JUNE 19, 1989

CHEMICAL & ENGINEERING

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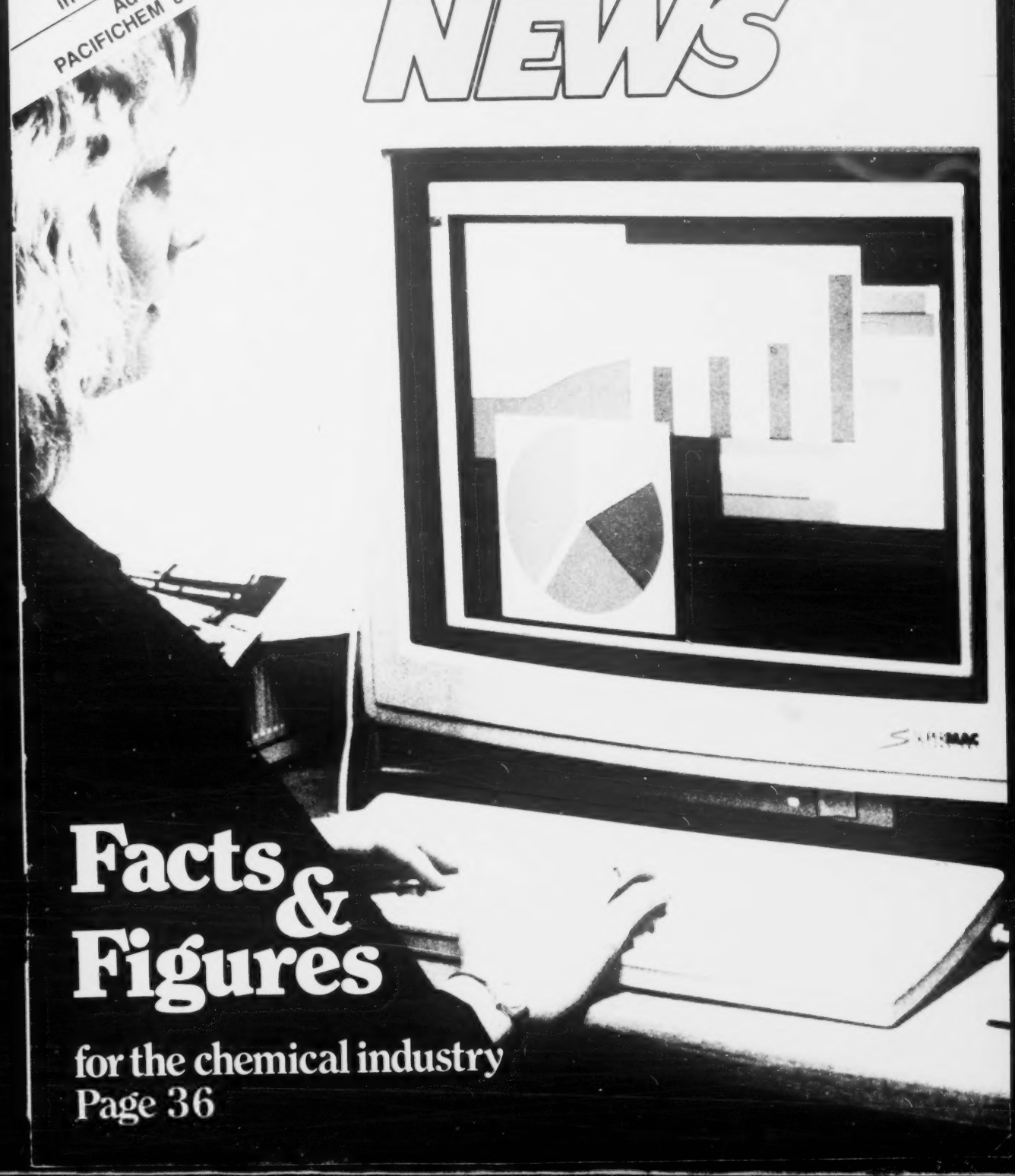

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for the chemical industry

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CHEMICAL & ENGINEERING NEWS

Volume 67, Number 25
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JUNE 19, 1989

News of the Week

■ **President Bush offers array of sweeping but costly programs to deal with acid rain, smog, emissions.** Page 5

■ **House panel investigating ethics in the science research community grills MIT's president on school's industrial liaison program.** Page 6

■ **Scientists at Virginia Polytechnic Institute develop new catalyst useful in commercially important hydroformylation reactions.** Page 7

■ **U.S.-China science, business relations chill following Chinese crackdown on pro-democracy demonstrators.** Page 8

Cover: Photo by C&EN's David J. Hanson

Business

Portugal's opening of its chemical industry to foreign investment and plans for single European Community market in 1992 were focus of CEFIC meeting in Lisbon. **Page 15**

Government

Occidental Chemical agrees to store and destroy wastes from Love Canal; Coalition for National Science Funding issues report calling for sustained funding of basic science research. **Page 20**

Science/Technology

Superconductor research leads to development of new devices; more research into fluid catalytic cracking, fluidization urged; improving the reliability of forecasting recommended as way to better global warming predictions. **Page 30**

ACS News

Committee on Professional Training reports on 1988 bachelor's, masters, and Ph.D. graduates of ACS-approved schools; University of California, Berkeley, was top producer of Ph.D. chemists. **Page 93**

Preliminary Program

198th ACS national meeting in Miami Beach: list of symposia, advance registration form. **Page 101**

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Advance information on the International Chemical Congress of Pacific Basin Societies in Honolulu, Dec. 17-22. **Page 120**

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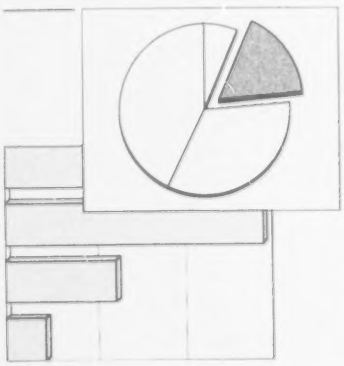

Facts & Figures

A banner year was chalked up by the chemical industry in 1988, both in the U.S. and worldwide. Output advanced smartly, profitability was much improved, and other business trends generally were favorable. C&EN's annual statistical package details recent progress. **Page 36**

Chemical & Engineering News

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LETTERS

Parliament reversed

SIR: It should be noted that the cover photograph on the March 6 issue of C&EN is reversed. The picture is taken facing north towards the Ottawa River. The outlet of the Rideau Canal, famous in connection with certain unmentionable events involving our two countries in 1812, should lie to the east of the parliament building—not, as it does in the photograph, to the west. Chemists visiting our capital should not use the picture to find their way around our parliament hill. The picture, like our science policy in Canada, is topsy-turvy.

Your article was most informative, and provided a perspective that was most revealing. Our government is bringing down the budget, and with the magnitude of the national debt, which is greater relative to the gross national product than yours in the states, restraint will be the keyword. Whether the government will have sufficient courage to support science more strongly than in the past is doubtful, even though improved GNP in the future will depend on support for research—especially basic research—now.

John Milne
Associate Professor of Chemistry
University of Ottawa

Pesticide risk

SIR: Your article on pesticide risk to children (C&EN, March 13, page 13) failed to investigate the science behind the hysteria. In fact, your statement that our fruits are "ladened with pesticide residue(s)," just adds more confusion and concern about our food supply system—one of the safest in the world.

Your article was based principally on a Natural Resources Defense Council report, "Intolerable Risk: Pesticides in our Children's Food." NRDC has labeled the Alar active ingredient daminozide and its metabolite, unsymmetrical dimethylhydrazine (UDMH), potent carcinogens. The scientific facts, however, do not support this allegation, and your article does nothing to reveal the real scientific facts in this case.

Daminozide is not mutagenic and not carcinogenic. Daminozide was first shown not to be carcinogenic in rats in 1966; recent studies (1988) in which daminozide was fed to rats and mice at levels up to 10,000 ppm in the diet showed no carcinogenicity. A battery of mutagenicity studies on daminozide were all negative.

UDMH was also not mutagenic in a battery of tests. Carcinogenicity studies are still in progress on UDMH in rats and mice. After one year of feeding, there is no carcinogenicity in rats at all doses, and none in mice at all doses but the highest dose. This high dose clearly exceeded the maximum tolerated dose as determined by severe liver damage leading to premature death. This high dose is 4 million times higher than human exposure. Clearly, UDMH is not a potent carcinogen, and there appears to be no health risk of cancer to humans from exposure to UDMH at low doses.

The NDRC report focused on UDMH studies published in 1973 that have been invalidated by the Environmental Protection Agency Scientific Advisory Panel, and discarded by EPA as unreliable for quantitative or qualitative risk assessment.

Alar does not pose a risk to human health. To the contrary, Alar helps growers produce healthier, higher quality apples that can be stored and enjoyed throughout the year.

J. A. Lacadie
Director, Crop Protection R&D
Uniroyal Chemical Co.
Middlebury, Conn.

Fluoridation of water

SIR: The review of the studies on fluoridation (C&EN, May 8, page 5) points up to my mind only one of the common flaws plaguing public health research.

Although the studies show little difference between populations using fluoridated vs. unfluoridated water, they do not address the real issue of how much fluoride the two theoretically different populations are actually receiving. The medical and dental community frequently compensate for lack of fluoride in drinking water. Standard pediatric practice is to prescribe vitamins with fluoride or fluoride supplements for children in unfluoridated areas. The advertising community is another source of fluoride outside the drinking water supply via fluoridated toothpastes and mouthwashes.

Fluoridation of children, not water, is the real issue. The fact that children did not change their address proves only that this population did not receive fluoride from water, not that it has not received fluoride. A nonfluoridated community is only a starting point from which to select out truly nonfluoridated subjects.

Mary Ellen Reitz
Pathologist, St. Vincent
Health Center, Erie, Pa.

CLEAN AIR: Bush urges broad, costly programs

Hoping to break a 12-year Congressional logjam and seize the political initiative, President Bush has offered sweeping but costly programs to abate acid rain, clear up urban smog, and control cancer-causing emissions from industrial plants and mobile sources. "There is no question but that there will be renewal of the Clean Air Act this year," comments Richard E. Ayres, chairman of the National Clean Air Coalition.

Bush's initiatives were offered only in broad brush strokes, tempering the generally positive responses. For example, House Energy & Commerce Committee chairman John D. Dingell (D.-Mich.) jabs the Reagan Administration's inaction while applauding Bush "for proposing the first comprehensive Clean Air Act revision in this decade." He adds that "the broad outlines appear reasonable, effective, and consistent with the need to promote economic growth and job opportunities." However, Senate majority leader George J. Mitchell (D.-Me.) cautions, "No final judgment can be made until the President submits specific legislation."

Dingell's comments were noted and appreciated by U.S. and Canadian environmental groups who in the past criticized the powerful committee chairman for successfully bottling up reauthorization efforts. Control of acid rain has long been a thorn in U.S.-Canadian relations in general. But Bush's plan received a favorable response from Prime Minister Brian Mulroney who welcomed it as "the most positive step by a U.S. Administration in more than a decade."

Briefly, Bush's clean air proposals would cut coal-fired electric utility emissions, which contribute to acid rain, nearly 50% a year by the year 2000. They would bring two thirds of about 80 smog-choked cities into compliance with the health-based ozone and carbon monoxide standards by 1995. And they would cut cancer-causing air emissions from factories and plants 75 to 90%. Environmental Protection Agency Administrator William K. Reilly estimates that these programs could cost as much as $18 billion a year when they're fully implemented around the turn of the century.

In an ironic twist, U.S. environmentalists find the acid rain proposals the best of the three-part plan, while some industries find them troublesome. National Coal Association president Richard L. Lawson characterizes some of them as "un-

Bush's three-pronged plan for clearing the air

ACID RAIN

Affected sources: 107 coal-fired power plants in 18 states.

Goals: Reduce from 1980 levels sulfur dioxide emissions 10 million tons annually, and nitrogen oxides 2 million tons annually, by year 2000.

Estimated cost: $700 million per year in first phase, $3.8 billion annually in second phase.

Features: Utilities adopting so-called clean coal repowering technologies to receive three-year extension of year 2000 deadline. Affected utilities allowed to trade in pollution rights.

AIR TOXICS

Affected sources: Motor vehicles and about 30 industrial categories, including chemical plants.

Goals: Regulate within 10 years 187 toxic air pollutants from 30 source categories. Prevent catastrophic chemical plant accidents. "Drastically" cut the 2.7 billion tons of toxics emitted annually.

Estimated cost: About $2 billion annually.

Features: Require emitters to use maximum available control technology, measured by EPA standard based on best technology currently available. Sources voluntarily cutting emissions before an enacted standard to receive credits against MACT requirement. After initial phase, EPA to determine if further controls necessary to protect against "unreasonable risk." Chemical safety board established.

URBAN SMOG

Affected sources: Motor vehicles, small sources such as dry cleaners and consumer solvents, and large sources such as petroleum refineries and refueling stations.

Goals: Attain ozone standard in all but three of the most seriously polluted cities by year 2000 by tightening hydrocarbon emission tailpipe standards for automobiles and light duty trucks.

Estimated cost: Up to $4 billion a year when fully implemented.

Features: Expanded vehicle inspection and maintenance programs in areas with serious smog problems. Phasing in of alternative fuels (ethanol, methanol, natural gas) in most serious nonattainment regions. A million clean-fueled vehicles per year to be introduced to these areas by 1997. Eventual regulations allowing automakers to engage in "emissions trading" and petroleum refiners in "fuel pooling."

necessary, unduly harsh, and economically onerous."

Based on the principle that the polluter pays, the plan places the burden of abating acid rain squarely on the shoulders of 107 coal-burning electric utilities in 18 states, centered primarily in the Midwest. These "dirty" utilities would have to cut sulfur dioxide emissions 5 million tons a year by 1995 and another 5 million tons a year by 2000. This is about a 50% reduction in current emissions. The utilities would also have to cut emissions of nitrogen oxides 2 million tons a year by the year 2000, a reduction of about one tenth current emissions.

Utilities would be allowed to achieve reductions by switching to lower sulfur coal, installing flue-gas scrubbers, encouraging conservation among their customers, or adopting innovative technology that permits the burning of fuel without producing pollution. Those utilities that opt for the latter choice would be given an additional three years beyond 2000 to comply.

In addition to the flexible means of achieving reductions, utilities would be allowed to trade pollution rights—buy and sell the right to pollute. Initially trading would only be allowed between plants in the same state or within the same utility system. Later, interstate trading would be permitted.

Under this system, the electric utility customers of the 107 plants can expect to see rate increases of more than 2%, says Energy Secretary James D. Watkins. In addition, consumers will be paying the higher rates without receiving the benefits of the reductions—a sticky point that has derailed past efforts to pass acid rain control legislation.

Although EPA has had no authority to regulate acid rain, it has had the legislative ability to control toxic air pollutants. It has fallen far short of doing so, mainly because it couldn't determine what the law's call for "margin of safety" meant. To date, EPA has regulated only seven toxic air pollutants, but Bush's plan raises the number to be regulated to 187. The President also proposes initiatives to address catastrophic Bhopal-like accidents and to drastically cut the 2.7 billion lb of toxic chemicals now being emitted to the air each year.

Bush proposes controlling such major sources of toxic air pollution as steel mills' coke ovens and chemical plants under a timetable that calls for EPA regulations for controlling 10 of 30 source categories within two years, and all remaining source categories within 10 years. Affected plants and factories will be required to use so-called maximum available control technology (MACT) to cut toxic emissions. This means that EPA will set a standard based on best technology currently available.

EPA is directed to encourage early voluntary compliance by allowing credit against the MACT requirement for those reductions made before the standard is published.

At a press briefing, EPA Administrator Reilly indicated that Bush's legislation will call for a chemical safety board patterned after the National Transportation Safety Board. As envisioned, this board would decrease the likelihood of a Bhopal-like accident by developing and maintaining a data inventory. The board also would be given the power to visit, inspect, analyze, and report on its recommendations following a major release of toxic chemicals.

All of these actions would be part of the first phase. In the next phase, EPA would determine if further controls were necessary to protect the public from "unreasonable risk," and set them if they were.

EPA estimates annual costs of the full air-toxic program at about $2 billion a year.

Chemical industry sources are generally pleased with the program, although they caution that few details are available. The Chemical Manufacturers Association particularly likes the technology-based approach to controlling toxic air pollutants. But CMA's environment division associate director Ann M. Mason says it is still unclear what is meant by best available technology.

The third prong of Bush's proposal addresses the seemingly intractable urban smog problem. He plans to get all but the three most seriously polluted cities into compliance with the ozone (smog) standard by 2000. He would do this by tightening vehicle tailpipe emissions, gasoline volatility requirements, and state inspection and maintenance programs; cutting vehicle evaporative emissions; and regulating toxic emissions from small businesses, consumer products, and hazardous wastes sites.

The most novel part of Bush's legislative package calls for the use of vehicles able to operate on such clean fuels as methanol, ethanol, and natural gas. His plan requires a phase-in of such vehicles, with 1 million vehicles a year being sold in the most seriously polluted areas by 1997. Oil and auto industry officials are unhappy with this package.

Lois Ember

C&EN staff photo

Bush: calls for chemical safety board

MIT industry/research ties questioned

Congress again is scrutinizing the science community's ethics—this time alleged financial conflicts of interest. The academician under fire last week was Massachusetts Institute of Technology president Paul E. Gray, who was grilled by a House panel exploring ties between industry and universities. MIT, the panel said, may be undermining U.S. industry by selling the results of publicly funded research to foreign corporations.

The hearing was held by the Hu-

Investment in Portugal, Plans for Europe 1992 Top CEFIC Agenda

Chief investment target in Portugal's chemical industry is state-owned Quimigal, which will sell all its operations except fertilizers

Patricia L. Layman, C&EN London

Foreign investment in Portugal's chemical industry and trends and problems in preparing for a single internal market in the European Community beginning in 1992 were the focus of discussions at the annual meeting of the European Chemical Industry Federation (CEFIC) held earlier this month in Lisbon.

Referring to the opening of Portugal's chemical industry to foreign investment and ownership, one delegate at the meeting said it's a "come, see, and bid" situation for foreign chemical companies interested in widening their pattern of investment in Western Europe.

Metz: firms lead transnational effort

Chief among the investment targets is Quimigal, the state-owned chemical producer with a variety of interests from commodities such as fibers and fertilizers to specialties, including plastics additives and precious metals. It was created in 1974 from three other chemical companies in an effort to gain some sort of economy of scale. But a host of crises fell upon the company: the two oil crises, collapsed demand, and bureaucratic decision-making incapable of moving as fast as the industry demanded. The result: Since its formation, Quimigal has been one of the major money-losing industries in Portugal.

It still is losing money, concedes Pedro Nunes, a member of the board of directors of the company. But internal restructuring of the company, the decision by the Portuguese government to absorb a hefty share of corporate debt, and the state's restructuring of the company's major business, fertilizers, has improved the company's operations. "There have been no direct financial profits since 1977," says Nunes. "But if you forget the debt interest, Quimigal has been in operating profit since 1986." Moreover, the company, which last year had sales of about $650 million, "will show profit from 1991 onwards," he predicts.

In the meantime, the company is—for all practical purposes—for sale. Only the fertilizers business, an industry of national strategic importance, does not carry a "for sale" sign. All the other operations could be negotiated for, Nunes indicates. A reorganization this February, creating separate new companies from the existing divisions, with the headquarters acting as a holding company, is expected to help any such negotiations.

Chemicals are serious balance of trade deficit for Portugal

$ Millions	1988	1987	1986	1985
Exports	596	586	488	441
Imports	1718	1418	863	633
Sales	$1783	$1702	$1500	$1059

Note: Figures were converted from escudos to U.S. dollars on the basis of $1.00 equals: 1988, 144 escudos; 1987, 141 escudos; 1986, 150 escudos; 1985, 170 escudos. Includes organic and inorganic chemicals, fibers, fertilizers, explosives, resins, and pesticides. **Sources:** European Chemical Industry Federation (CEFIC), International Monetary Fund

Also for sale are sites at the major chemical complexes owned by Quimigal—500,000 square meters of open land and 100,000 sq m of built-up land, which the company is attempting to turn into an industrial park. Existing amenities include road and rail links with Lisbon and the rest of Europe; a deepwater harbor; and water, steam, and electrical supplies—all the infrastructure elements that could appeal to prospective investors, Nunes says.

The Quimigal restructuring follows closely after the Portuguese government's move late last year to invite tender offers for some of the other state-held petrochemical operations. Finnish petrochemicals producer Neste has already snapped up the polyethylene and polypropylene plants being sold by the state in a consortium with two Portuguese companies (C&EN, March 20, page 10). These plants had been owned by Empresa de Polímeros de Sines. Neste would also lease the ethylene feedstock supply.

And when the industry and the state are ready, other nationally owned chemical interests will be privatized, government officials say. "Any investment is welcome," says one official in the department of

industry. "Our real priority is creating links between national and international companies—for example, with companies who want joint ventures. We don't want just foreign capital, but know-how and technology."

The Portuguese industry has made significant strides back to health, notes Günter Metz, vice chairman of the board of management at West German chemical producer Hoechst, and current president of CEFIC. In his address to the meeting's general assembly, he offered his congratulations to the Portuguese chemical industry. "I believe," he said, "that the past five years have seen your industry take important strides forward."

Such strides, he says, have been particularly important in helping Portugal's economic and political integration into the European Community. The EC, in fact, was at the heart of Metz's concerns during the assembly. CEFIC, he says, is looking beyond the single internal market of 1992, and has established a task force, CEFIC 2000, to identify issues that will be facing the industry by the turn of the century and ways the federation can address the issues.

Finnish industry proposes environment initiative for Europe

At the Lisbon general assembly of the European Chemical Industry Federation (CEFIC), the Finnish Chemical Industry Federation introduced its "environment initiative," presented to its government in late May, to put together a body to fund environmental protection and cleanup throughout Europe, particularly the East bloc.

The rest of the national representatives from CEFIC clearly were surprised by the initiative, as Gunter Metz, current CEFIC president, admitted during a press conference. And he saw practical problems with the proposal. However, he emphasized, "if there is a possibility, we should use it—the environment is a European problem."

CEFIC was presented the same proposal put forward in May by the board of directors of the Finnish Chemical Industry Federation to the Council of State to create—with extensive international cooperation—a financing system for environmental protection throughout the whole of Europe.

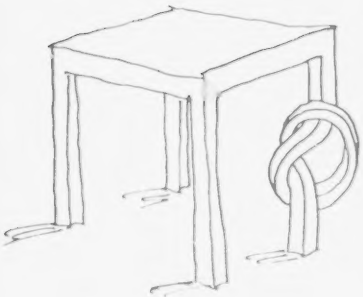
Says the federation's working proposal: "The effectiveness of the results [to reduce the emission of pollutants and the development of technology designed to spare the environments] is diminished by the fact that the situation is not the same throughout Europe. Emissions harmful to the environment are carried by the wind and water irrespective of national boundaries. Not all of the countries have been able to achieve even a moderate minimum level of environmental protection.

"The emissions derived from Eastern European countries represent a particular threat to the future of the state of the environment in the whole of Europe. The socialist countries, with their economic problems, have not been able to invest sufficiently in environmental protection during the past decades.

"The need for environmental protection technology has become increasingly apparent in both discussions at the company level and in the official working groups of the chemical industries of Finland and the socialist countries. It has also become apparent that information about suitable technology is not, in itself, enough. External financing is also required. The problems are so immense that normal commercial financing will hardly suffice.

"Funds directed at environmental protection in the industry of Finland and a number of other European countries will bring about only a marginal improvement in the state of the environment in the whole of Europe if the above-mentioned immense problems are not solved.

"Finland proposes the establishment of a European Environmental Protection Fund, which would finance environmental protection investments in those countries whose economic situation has so far not permitted it. This would provide a solution to the great problems threatening the environment in Europe in the very areas where the problems are most acute."



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Among the issues is centralization of decision-making within the EC. "No sooner have we become accustomed to the challenges of the single market liberalizations, than we are faced with the much more demanding issue of how far we should abandon our ingrained national prerogatives and cede an unprecedented degree of sovereignty to the center," Metz says.

Companies, Metz says, are leading the transnational movement. "Companies are beginning to think in terms of investing in different parts of Europe, when before they contented themselves with investing in different regions of their own country."

However, national governments are the slow partner. "The process of Europeanization is not happening fast enough when it comes to national administrations, specifically in the area of environmental regulation," he warns. The authorities in EC member states "are, in fact, creating chaos in the chemicals sector by burdening us with wildly differing national environmental rules. These different national regulations are making it harder to tackle Europe's environmental problems and are liable to create trade distortions that will lead to fragmentation of the Common Market just at the point when we thought movement was at last in the other direction."

One specific problem is waste management, which—rather than being dealt with on an international basis—is threatened by national controls, or the banning of transfrontier movement of waste. This would pose a threat to the establishment of specialized treatment plants now being proposed to serve the whole European industry. "Given the cost of setting up such facilities, it would be absurd to do so on a national basis," Metz says.

CEFIC is banking in part on its corporate members, who are affiliated via the Assembly of Corporate Associate Members, to help with some gentle lobbying. "The ACAM members are of increasing importance—those companies are European, not national. We need their expertise for our negotiations with the European Commission and the European Parliament," Metz says. □

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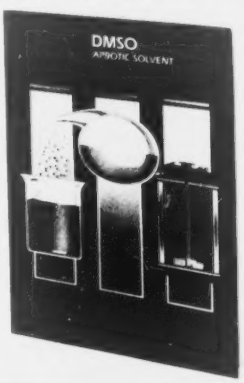

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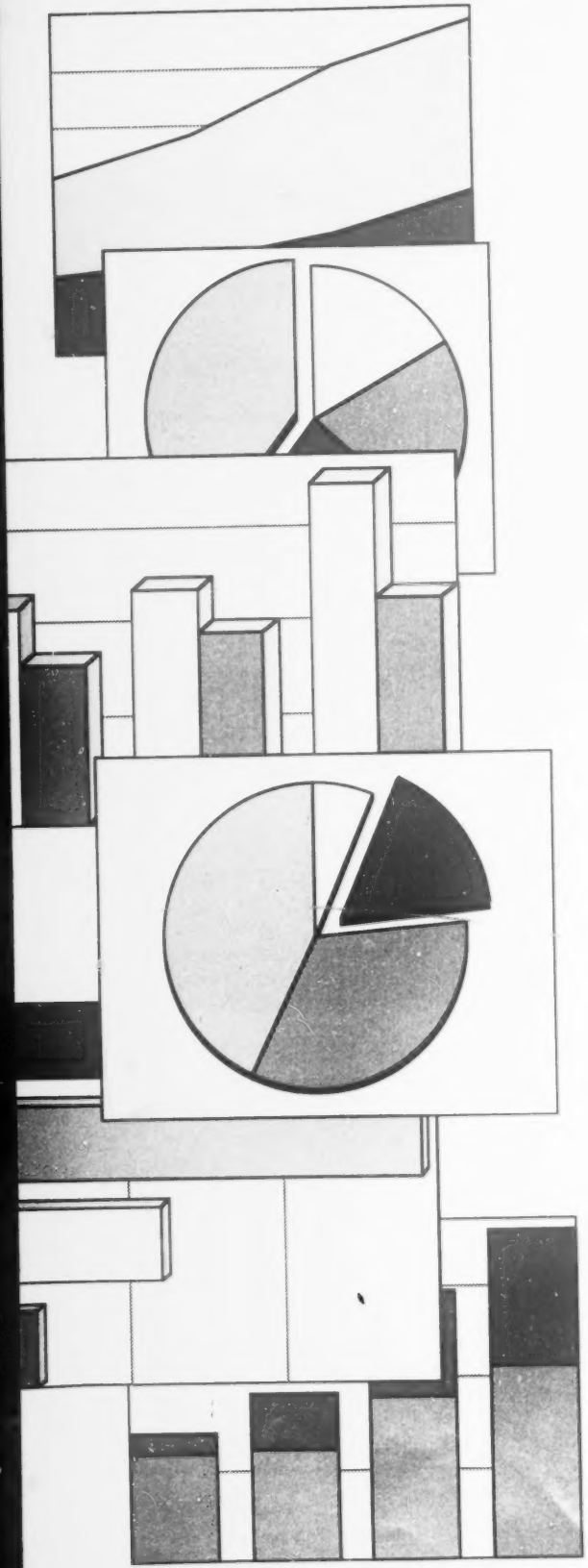
CIRCLE 57 ON READER SERVICE CARD



Facts

for the chemical industry

The data in the graphs and tables on the following pages of C&EN's annual Facts & Figures issue clearly show that the business climate of the late 1980s has been remarkably favorable for the chemical industry, not only in the U.S. but worldwide.

Last year, in fact, was by many measures the best in recent memory. With demand vigorous, chemical producers were selling more of their products at higher prices, were operating smoothly and efficiently, and in many cases were earning

at a glance

1 Production

Output of chemicals in the U.S. in 1988 was 8% higher than the year before. Although production has been rising steadily since the 1982 recession, last year's increase was the biggest since the initial recovery year of 1983. Clearly, the industry's recovery from its early 1980s' slump has had remarkable staying power. As usual, plastics and organic intermediates were the product lines setting the fastest pace. But synthetic rubber also was strong, and an uptrend for fertilizers bolstered some of the inorganic chemicals used in making them. Fiber output was a mixed bag; it was a relatively good year for olefins and polyester but a stagnant one for nylon and acrylics.

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& Figures

more than ever before. Financially, the industry was trim but sturdy. Funding for new plants and for increased research was on the upswing.

This year promises to bring further expansion. Nevertheless, some clouds are hovering on the horizon. Signs of slackening growth in many major markets in the U.S. are apparent. And with capacity increasing at the same time, the positive trend in selling prices of the past few years is coming under increasing pressure. With a good first half already under its belt, the chemical industry is still confident that 1989 will be another year of progress. But when the statistics for the year are displayed in Facts & Figures next June, they may not have quite the rosy hue that is so evident this year.

2 Finances

Chemical companies' profitability strengthened remarkably during 1988, buoyed by the heady combination of higher demand, strong prices, rising productivity, and generally effective cost control. Because sales are strong, the industry has been hiking its outlays for new plant and equipment; a C&EN survey of major chemical producers indicates that they invested 34% more last year than in 1987. And they plan another big boost in capital spending again this year. Budgets for R&D also are climbing. Page 51

3 Employment

Employment in the chemical industry continued to rebound from its low point of late 1986 and early 1987. But the 3% increase last year still kept the total number of people working in the industry well under the level of the early 1980s. And with employment of production workers still relatively low despite rapid growth in output, productivity in the industry has continued to expand and now stands nearly 50% above the level of a decade ago. Page 67

4 Markets

Consumers continued to be liberal spenders during 1988, underpinning the overall U.S. economy and fueling demand for chemical products. Some major markets for chemicals, however, were less buoyant last year, suggesting that overall growth for chemicals may soon show signs of slackening. Two important ones are housing construction, which dipped for the second year in 1988, and auto assembly. Demand remained firm, however, from such industries as textiles, paper, and tires. Page 74

5 Foreign Trade

With continued weakness in the dollar permitting U.S. chemical producers to price their products competitively in overseas markets, exports of chemicals from the U.S. climbed more than 20% to an impressive all-time high of $32.3 billion. Imports of chemicals rose, too, at about the same rate. But that did not prevent the chemical balance of trade from swelling to a record $12.4 billion, and U.S. exporters managed to win a larger share of the global market for chemicals for the first time since 1985. Page 76

6 Foreign Chemical Industries

Business was prosperous for chemical producers throughout the industrialized world last year. As a result, reports from Western Europe, Japan, and Canada all have a similar tone: Output was higher, prices were strong, operating costs were under control, and consequently profitability was much improved. Growth was also apparent elsewhere, including China and several of the other Pacific Rim nations. But it was less robust in the Soviet Union and some of its East European satellites. Page 79

1 Production by the U.S. Chemical Industry

Growth maintains a strong pace

Production growth of the U.S. chemical industry was even stronger in 1988 than it was in 1987. Output rose 8% last year, compared with 6% in 1987 and 5% in 1986, making 1988 the sixth straight year of expansion and the year of greatest growth. Chemicals did somewhat better than industry as a whole in 1988; total industrial production was up only 6%.

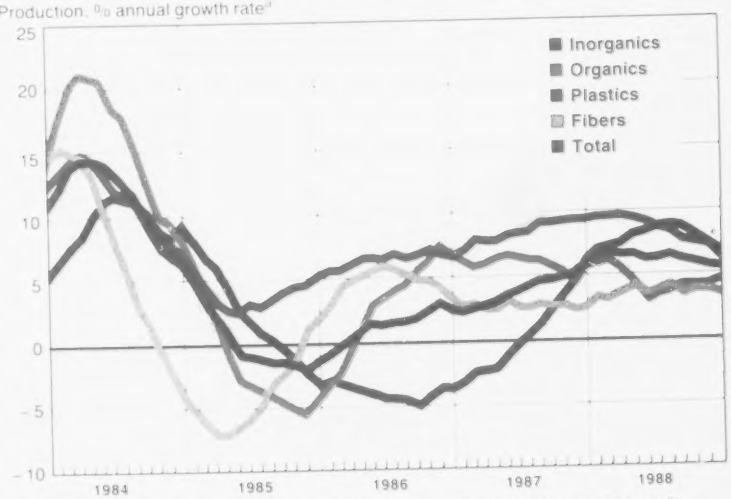
Some of the strongest sectors of the chemical industry were organic chemicals, plastics, drugs, soap and toiletries, agricultural chemicals, and synthetic rubber. Plastics production rose an overall 9%, with epoxy resins up 14%, thermoplastic polyester up 19%, and styrene-acrylonitrile—a relatively small volume resin—leading the way at 17%.

Output of inorganic chemicals, as measured by the Federal Reserve Board's production index, was down slightly in 1988 after recovering somewhat in 1987. Even though industrial gases and inorganic pigments rose moderately, production losses for some major inorganic chemicals pulled the total down.

Output of all fertilizers except concentrated superphosphate rose in 1988, but ammonium nitrate and concentrated superphosphate have experienced an overall decline in the past six years. Consumption of phosphate and potash nutrients also has declined during the past decade.

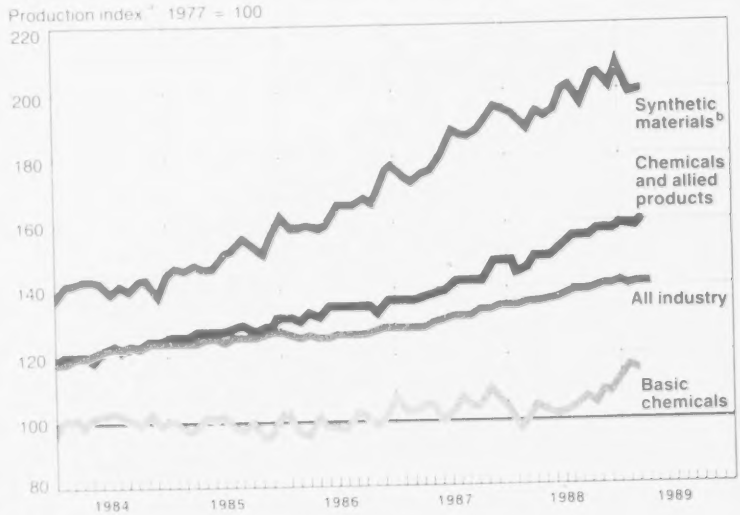
For most minerals used for making chemicals, output was up last year, but for the majority production is still below 1978 levels. Noncellulosic fibers as a whole grew in 1988, although acrylic and nylon output both fell 1%. Even though acetate and rayon production grew slightly, they remain much lower than they were a decade ago. Likewise, synthetic rubber production is also up, as it has been since 1986, but it, too, has experienced an overall decline in the past decade.

All chemical sectors posted further steady growth in 1988



a Average running annual growth rates in production of major plastics, inorganic and organic chemicals, and all chemicals, and in shipments of man-made fibers. **Sources:** International Trade Commission, Bureau of the Census, Society of the Plastics Industry, Textile Economics Bureau

Uptrend continues in chemical production



a [illegible] b [illegible]

Source: [illegible]

TOP 50 CHEMICALS: Increases in output for past two years well above average for past decade

Rank 1988	Rank 1987[a]		Billions of lb 1986[d]	Billions of lb 1987	Common units[b] 1988	Common units[b] 1987	Average annual growth 1987-88	1986-87	1983-88	1978-88
1	1	Sulfuric acid	85.56	77.50	42,779 tt	38,750 tt	10.4%	5.2%	2.7%	0.3%
2	2	Nitrogen	52.10	47.39	719 bcf	654 bcf	9.9	−2.5	5.1	6.3
3	5	Oxygen	37.09	32.28	448 bcf	390 bcf	14.9	−2.3	5.3	0.5
4	3	Ethylene	36.56	34.99	36,562 mp	34,992 mp	4.5	6.5	5.0	3.5
5	4	Ammonia	33.89	32.32	16,946 tt	16,161 tt	4.9	15.4	4.0	−0.1
6	6	Lime[c]	32.34	30.36	16,169 tt	15,182 tt	6.5	2.3	1.7	−2.3
7	7	Sodium hydroxide	23.97	23.04	11,983 tt	11,518 tt	4.0	7.7	3.2	0.6
8	9	Phosphoric acid	23.43	20.95	11,717 tt	10,473 tt	11.9	13.8	3.7	2.0
9	8	Chlorine	22.66	21.96	11,329 tt	10,980 tt	3.2	5.2	2.6	0.2
10	10	Propylene	19.97	18.53	19,966 mp	18,527 mp	7.8	12.1	7.4	4.4
11	11	Sodium carbonate[d]	19.10	17.78	9,550 tt	8,891 tt	7.4	5.4	2.4	1.4
12	13	Nitric acid	15.78	14.20	7,889 tt	7,102 tt	11.1	8.2	2.5	−0.1
13	12	Urea[e]	15.76	14.88	7,878 tt	7,441 tt	5.9	23.4	5.6	2.3
14	15	Ammonium nitrate[f]	14.38	12.83	7,188 tt	6,416 tt	12.0	15.5	2.9	0
15	14	Ethylene dichloride	13.65	13.81	13,652 mp	13,805 mp	−1.1	6.7	3.5	2.2
16	16	Benzene	11.84	11.67	1,608 mg	1,585 mg	1.5	16.4	5.5	0.8
17	18	Ethylbenzene	9.94	9.41	9,936 mp	9,409 mp	5.5	4.3	4.8	1.7
18	20	Terephthalic acid[g]	9.60	8.11	9,604 mp	8,110 mp	18.4	5.5	11.3	4.9
19	17	Carbon dioxide[h]	9.38	9.86	4,691 tt	4,932 tt	−4.9	1.0	3.7	4.0
20	19	Vinyl chloride	9.06	8.23	9,056 mp	8,230 mp	10.0	−2.5	5.7	2.7
21	21	Styrene	8.59	8.09	8,588 mp	8,090 mp	6.2	2.6	4.8	1.8
22	22	Methanol	7.34	7.29	7,343 mp	7,292 mp	0.7	1.2	−1.7	1.3
23	24	Formaldehyde[i]	6.73	6.08	6,730 mp	6,077 mp	10.7	9.5	4.3	0.5
24	23	Toluene[j]	6.47	6.73	892 mg	928 mg	−3.9	51.9	2.7	−1.7
25	25	Xylene	5.93	5.72	824 mg	795 mg	3.6	27.6	2.6	−0.3
26	28	Hydrochloric acid	5.87	4.99	2,933 tt	2,495 tt	17.6	3.4	3.9	0.5
27	27	*p*-Xylene	5.60	5.15	5,598 mp	5,152 mp	8.7	2.3	6.4	4.8
28	26	Ethylene oxide	5.37	5.62	5,365 mp	5,623 mp	−4.6	3.6	−0.6	0.5
29	29	Ethylene glycol	4.90	4.52	4,899 mp	4,515 mp	8.5	−5.4	2.1	2.3
30	31	Cumene	4.80	4.15	4,800 mp	4,151 mp	15.6	10.8	7.5	3.6
31	32	Methyl *tert*-butyl ether[k]	4.68	3.37	4,684 mp	3,372 mp	38.9	−0.1	41.0	na
32	30	Ammonium sulfate	4.67	4.37	2,337 tt	2,183 tt	7.1	4.7	3.6	−0.5
33	33	Phenol[l]	3.53	3.24	3,528 mp	3,241 mp	8.9	4.0	6.0	2.8
34	36	Potash[m]	3.35	2.78	1,520 tmt	1,262 tmt	20.4	5.0	1.2	−3.9
35	35	Butadiene[n]	3.19	3.00	3,194 mp	3,002 mp	6.4	15.8	6.3	−1.0
36	34	Acetic acid	3.16	3.23	3,164 mp	3,227 mp	−2.0	18.3	2.4	1.3
37	38	Propylene oxide	3.11	2.61	3,110 mp	2,608 mp	19.2	5.2	10.8	4.3
38	37	Carbon black	2.92	2.72	2,916 mp	2,724 mp	7.0	5.4	3.2	−1.4
39	41	Aluminum sulfate	2.59	2.45	1,297 tt	1,223 tt	6.1	0.1	3.3	−0.1
40	39	Acrylonitrile	2.58	2.55	2,576 mp	2,551 mp	1.0	16.9	3.7	3.9
41	40	Vinyl acetate	2.56	2.51	2,561 mp	2,505 mp	2.2	46.5	5.5	4.2
42	42	Cyclohexane	2.32	2.25	2,319 mp	2,250 mp	3.1	8.6	7.0	−0.1
43	43	Acetone	2.29	2.08	2,285 mp	2,082 mp	9.8	7.5	4.2	−1.0
44	44	Titanium dioxide	2.04	1.90	1,021 tt	952 tt	7.2	2.3	6.2	3.8
45	46	Sodium sulfate[o]	1.69	1.61	845 tt	805 tt	5.0	3.9	−0.2	0.4
46	44	Sodium silicate	1.64	1.90	821 tt	952 tt	−13.8	21.1	2.4	−0.1
47	47	Adipic acid	1.59	1.57	1,588 mp	1,572 mp	1.0	3.3	4.4	−0.2
48	49	Isopropyl alcohol	1.42	1.31	1,418 mp	1,313 mp	8.0	0.9	3.2	−2.0
49	48	Calcium chloride[p]	1.31	1.55	657 tt	773 tt	−15.0	−0.9	−5.2	−4.4
50	50	Caprolactam	1.26	1.16	1,261 mp	1,161 mp	8.6	4.7	5.2	3.2
		TOTAL ORGANICS	215.79	201.87			5.9	9.6	5.2%	2.4%
		TOTAL INORGANICS	225.76	184.74			8.5	4.9	3.3%	0.8%
		GRAND TOTAL	609.53	566.61			5.6	6.5	4.0	1.3%

a Revised. **b** tt = thousands of tons, bcf = billions of cubic feet, mp = millions of pounds, mg = millions of gallons, tmt = thousands of metric tons. **c** Except refractory dolomite. **d** Natural and synthetic. **e** 100% basis. **f** Original solution. **g** Includes both acid and ester without double counting. **h** Liquid and solid only. **i** 37% by weight. **j** All grades. **k** Production data for earlier years unavailable. **l** Synthetic only. **m** K_2O basis. **n** Rubber grade. **o** High and low purity. **p** Solid and liquid. na = not available.

PRODUCTION

Except for inorganic chemicals, 1988 was a year of healthy expansion

Industrial production indexes, 1977 = 100	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	Annual change 1987–88	Annual change 1978–88
Total index	137.2	129.8	125.1	123.7	121.4	109.2	103.1	111.0	108.6	110.7	106.5	6%	3%
Manufacturing, total	142.8	134.7	129.1	126.4	123.4	110.2	102.2	110.5	108.2	111.5	107.1	6	3
Nondurable manufacturing	143.9	136.8	130.1	124.6	122.3	113.7	105.5	109.7	107.0	108.2	105.5	5	3
Chemicals and products	151.9	140.2	132.0	126.4	121.6	114.0	103.8	112.6	106.4	111.4	106.8	8	4
Chemicals and synthetic materials	145.2	135.6	123.8	118.6	114.7	109.1	95.4	109.4	99.4	113.7	106.2	7	3
Basic chemicals	103.9	104.9	98.9	100.0	100.6	95.0	90.6	104.3	107.2	110.1	110.7	−1	−1
Alkalies and chlorine	102.2	103.4	97.5	97.1	97.8	91.5	83.3	96.1	104.1	113.6	101.7	−1	0
Industrial gases	158.0	150.3	128.3	127.0	123.6	114.0	103.9	115.4	105.0	107.2	98.7	5	5
Inorganic pigments	103.9	100.5	99.6	96.2	95.4	91.5	81.7	99.0	97.6	100.8	103.5	3	0
Inorganic chemicals, nec	95.2	98.2	94.1	96.5	97.9	92.9	90.9	104.6	109.4	111.1	115.3	−3	−2
Industrial organic chemicals	134.9	122.9	112.7	109.2	106.2	104.0	90.3	105.5	89.1	108.1	104.5	10	3
Synthetic materials	195.1	181.7	162.6	149.4	140.3	129.0	108.0	120.2	110.1	125.8	112.2	7	6
Plastics materials	275.3	252.5	220.0	197.4	179.8	158.7	129.9	136.1	122.1	132.6	115.6	9	9
Synthetic rubber	100.2	92.7	96.5	96.8	107.6	98.3	86.8	91.2	93.0	112.1	99.0	8	0
Man-made fibers	106.2	104.3	98.5	95.3	94.1	95.4	82.9	104.6	97.3	119.4	110.2	2	0
Chemical products	167.0	152.1	147.5	139.3	132.4	123.2	114.7	116.5	113.7	110.1	106.7	10	5
Drugs and medicines	151.5	138.3	134.8	126.4	121.7	118.8	114.2	112.0	112.9	107.5	105.1	10	4
Soap and toiletries	210.2	188.9	182.9	168.1	155.9	139.9	125.4	129.6	121.5	115.0	106.6	11	7
Paints	107.0	100.5	100.1	98.6	92.9	90.1	83.5	86.7	89.7	95.0	104.7	6	0
Agricultural chemicals	100.8	92.4	85.7	96.1	98.2	86.9	90.2	109.2	107.3	103.9	97.5	9	0
Petroleum products	96.0	93.5	92.6	86.9	87.4	84.0	84.2	89.4	94.0	101.7	102.5	3	−1
Rubber and plastics products	174.4	163.6	151.4	146.1	143.5	124.3	110.2	116.4	107.8	114.9	107.5	7	5

nec = not elsewhere classified. **Source:** Federal Reserve Board

MINERALS

Despite recent gains, output for most chemical minerals is still below 1978 level

Thousands of tons	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	Annual change 1987–88	Annual change 1978–88
Bromine, sold or used[a]	180	168	155	160	193	185	200	189	189	249	223	7%	−2%
Calcium chloride, production[b,c]	657[d]	773[d]	780	940	1,036	912	853	917	811	981	1,031	−15	−4
Iodine, consumption[e,f]	na	na	na	na	3.8	4.1	3.4	4.4	4.4	4.4	4.0	na	na
Imports[f]	1.4[d]	1.3	1.6	2.7	2.6	3.1	2.3	3.0	3.1	3.1	3.4	8	−8
Lime, sold or used[g]	16,700	15,733	14,474	15,690	15,922	14,867	14,075	18,890	19,037	20,983	20,484	6	−2
Lithium, consumption[e,h]	3.1[d]	2.7	2.6	2.5	3.2	2.2	2.0	3.2	3.0	3.2	3.4	15	−1
Phosphate rock													
Marketable production	50,000	45,145	44,445	56,035	54,230	46,928	41,241	59,110	59,962	56,891	55,156	11	−1
Exports	9,235	9,319	8,651	10,071	12,707	13,239	10,849	11,458	15,737	15,827	14,187	−1	−4
Potash (K_2O equivalent)[i]													
Production	1,680[d]	1,391	1,325	1,429	1,724	1,575	1,967	2,377	2,468	2,453	2,484	21	−4
Imports[j]	4,500[d]	4,490	4,643	5,063	5,323	4,894	4,253	5,287	5,481	5,693	5,189	0	−1
Apparent consumption	5,429[d]	5,609	5,338	5,893	6,638	6,231	5,647	6,849	6,999	7,626	6,840	−3	−2
Salt, total sold or used[k]	37,500[d]	36,493	36,663	40,067	39,225	34,573	37,894	38,915	40,396	45,820	42,896	3	−1
Evaporated[l]	6,800[d]	5,700	6,233	6,010	5,492	5,532	5,305	6,209	6,358	6,248	5,872	19	1
Rock[l]	12,400[d]	12,100	13,565	14,023	13,337	12,446	12,884	11,871	11,806	14,891	14,688	2	−2
Salt in brine[l]	18,400[d]	17,850	16,865	20,034	20,397	16,595	19,705	20,835	22,231	24,681	22,336	3	−2
Sodium carbonate, production[k]	9,550	8,891	8,438	8,511	8,511	8,467	7,819	8,281	8,275	8,253	8,290	7	1
Sulfur, production[m]	11,845	11,616	12,221	12,797	11,742	10,240	10,788	13,388	13,080	13,339	12,318	2	0
Apparent consumption[n]	14,012	12,481	11,669	13,192	13,976	12,112	11,088	14,093	15,056	15,145	13,889	12	0
Frasch, production	3,499	3,530	4,457	5,524	4,622	3,530	4,641	6,997	7,044	7,007	6,226	−1	−6
Recovered elemental, production	7,103	6,791	6,411	5,857	5,747	5,462	4,855	4,695	4,490	4,486	4,478	5	5
Other, production	1,243	1,296	1,354	1,416	1,372	1,249	1,293	1,695	1,547	1,845	1,615	−4	−3

a Elemental bromine sold as such or used in preparation of bromine compounds by primary producers. b 75% $CaCl_2$ equivalent. c Natural and synthetic. d Preliminary figure. e Estimated apparent consumption. f Crude elemental iodine. g Includes Puerto Rican production. h Lithium content basis. i Includes muriate and sulfate of potash, potassium magnesium sulfate, and parent salts; excludes other chemical compounds containing potassium. j Includes nitrate of potash. k Total obtained by all recovery methods that was sold or used by domestic producers (figures differ slightly from U.S. production figures); figures for 1978–81 include Puerto Rican production. l Sold or used as such. m Sulfur content basis. n Calculated from shipments plus imports minus exports (sulfur content basis). na = not available. **Source:** Bureau of Mines

1 Production by the U.S. Chemical Industry

ORGANIC CHEMICALS: 1987's strong rise was often repeated in 1988

Millions of lb unless otherwise noted	Production											Annual change	
	1988[a]	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1987–88	1978–88
Acetic acid, synthetic	3,164	3,246	2,728	2,897	2,619	2,807	2,748	2,705	2,977	3,265	2,776	−3%	1%
Acetone	2,285	1,846	1,910	1,788	1,862	1,859	1,694	2,144	2,076	2,653	2,519	24	−1
Acrylonitrile	2,576	2,452	2,182	2,349	2,219	2,146	2,035	1,997	1,830	2,018	1,752	5	4
Aniline	1,032	829	824	716	786	663	557	634	659	690	606	24	5
Benzene, mg[b,c]	1,608	1,585	1,362	1,283	1,318	1,232	1,052	1,308	1,534	1,612	1,435	1	1
Bisphenol A	1,077	1,000	956	949	762	643	480	555	530	576	471	8	9
1,3-Butadiene[d]	3,194	2,931	2,546	2,340	2,452	2,353	1,915	2,986	2,799	3,583	3,515	9	−1
1-Butanol	1,194	1,155	881	716	908	833	730	809	790	766	756	3	5
Caprolactam	1,261	1,156	1,109	1,089	1,027	977	793	928	905[e]	945	919	9	3
Carbon tetrachloride	759	672	627	646	713	573	587	726	710	714	737	13	0
Chloroform	524	462	422	275	405	362	299	405	273	356	349	13	4
Cumene	4,800	4,105	3,745	2,627	3,754	3,345	2,743	3,309	3,459	3,917	3,380	17	4
Cyclohexane	2,319	2,276	2,070	1,657	1,994	1,656	1,275	1,820	1,964	2,425	2,332	2	0
Dioctyl phthalate	334	343	296	275	301	300	266	304	353	336	409	−3	−2
Dodecylbenzene[e]	na	na	851	547	561	545	509	535	563[f]	627	526	na	na
Ethanol, synthetic	na	574	529	649	1,060	1,077	1,023	1,317	1,451	1,408	1,267	na	na
Ethanolamines[g]	611	627	543	537	504	468	416	429	376	420	362	−3	5
Ethylbenzene	9,936	9,346	9,020	7,386	7,562	7,876	6,656	7,813	7,642	8,448	8,385	6	2
Ethyl chloride	152	155	164	171	290	282	339	324	396	582	540	−2	−12
Ethylene	36,562	34,951	32,859	29,847	31,383	28,680	24,501	29,418	28,667	29,904	25,955	5	3
Ethylene dichloride	13,652	12,197	12,940	12,101	10,710	11,506	7,619	9,974	11,108	11,794	11,001	12	2
Ethylene glycol	4,899	5,183	4,771	4,178	4,823	4,425	4,309	4,143	4,386	4,729	3,904	−5	2
Ethylene oxide	5,365	4,785	5,430	5,430	5,699	5,534	4,987	4,937	5,220	5,665	5,012	12	1
2-Ethylhexanol	731	662	571	536	541	387	325	389	367	318	420	10	6
Formaldehyde, 37%[h]	6,730	5,733	5,549	5,606	5,815	5,465	4,817	5,721	5,555	5,971	6,381	17	1
Isopropyl alcohol	1,418	1,371	1,301	1,235	1,394	1,209	1,380	1,669	1,836	1,900	1,730	3	−2
Maleic anhydride	429	382	359	394	359	299	260	293	304	323	341	12	2
Methanol, synthetic	7,343	7,537	7,205	5,003	8,186	7,982	7,555	8,577	7,153	7,367	6,443	−3	1
Methyl chloride	428	373	605	410	482	409	366	405	362	463	454	15	−1
Methyl ethyl ketone	506	672	600	537	543	531	468	614	692	716	644	−25	−2
Methyl methacrylate	1,098	1,029	943	858	917	844	721	592	564	633	570	7	7
Methylchloroform	724	694	652	869	675	586	595	611	587	656	661	4	1
Methylene chloride	504	516	566	467	607	584	532	891	780	931	na	−2	na
Perchloroethylene	495	473	414	678	573	547	585	691	765	773	725	5	−4
Phenol, synthetic[i]	3,528	3,351	3,115	2,841	2,889	2,638	2,023	2,578	2,568	2,981	2,682	5	3
Phthalic anhydride	1,141	1,035	863	820	870	838	684	870	818	1,013	978	10	2
Propylene[j]	19,966	19,019	16,522	14,887	15,559	13,959	12,535	13,482	13,676	14,198	13,014	5	4
Propylene glycol	930	747	573	500	462	484	400	473	488	610	547	24	5
Styrene, monomer	8,588	8,014	7,888	7,622	7,709	6,802	5,942	6,679	6,856	7,484	7,186	7	2
Terephthalic acid, dimethyl ester[k]	9,604	7,601	6,257	6,490	5,912	5,626	4,843	6,235	6,054	6,159	5,954	26	5
Toluene, mg[b,l]	892	928	611	698	728	780	714	852	1,010	1,001	1,046	−4	−2
Vinyl acetate	2,561	1,813	1,710	2,112	2,024	1,963	1,876	1,936	1,922	1,982	1,692	41	4
Vinyl chloride	9,056	8,402	8,439	9,463	6,084	6,875	4,902	6,874	6,466	6,389	6,941	8	3
***o*-Xylene**	945	940	788	675	688	781	802	918	995	1,082	1,013	1	−1
***p*-Xylene**	5,598	5,155	5,035	4,779	4,264	4,114	3,391	4,532	4,238	4,650	3,516	9	5

Note: mg = millions of gallons. a Preliminary. b Tar distillers and coke-oven operators not included. c Specification grades. d Rubber grade. e Includes straight-chain dodecylbenzene, tridecylbenzene, and other straight-chain alkylbenzenes. f Preliminary figure, final figure not available. g Mono-, di-, and triethanolamines. h By weight. i Does not include data for coke ovens and gas-retort ovens. j All grades. k Includes both acid and dimethyl ester (DMT), without double counting. l High-purity toluene, includes material used in blending motor fuel. na = not available. **Source:** International Trade Commission

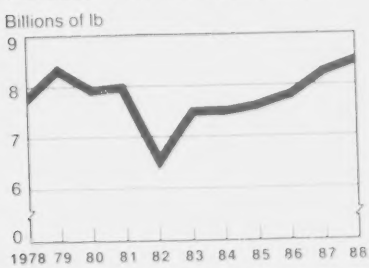
1 Production by the U.S. Chemical Industry

INORGANICS: For many products, output is little changed from 10 years ago

Thousands of tons unless otherwise noted	Production										Annual change	
	1988[a]	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1987–88	1978–88
Aluminum sulfate[b]	1,299	1,264	1,222	1,268	1,129	1,119	1,154	1,294	1,286	1,315	1,309	3%	0%
Ammonia, 100%[c,d]	16,937	16,095	14,474	17,319	16,692	14,072	15,801	19,044	19,653	18,634	17,119	5	0
Ammonium nitrate, 100%[e]	7,186	6,547	6,089	6,776	7,146	6,240	7,091	8,861	9,128	8,293	7,210	10	0
Ammonium sulfate,[d,f] 100%	2,337	2,189	2,080	2,093	2,067	1,956	1,768	2,185	2,136	2,363	2,449	7	0
Chlorine gas[g]	11,330	11,019	10,436	10,402	10,700	9,960	9,176	10,763	11,421	12,291	11,052	3	0
Hydrochloric acid, 100%[h]	2,834	2,869	2,413	2,807	2,732	2,468	2,450	2,574	2,888	3,090	2,793	−1	0
Hydrogen, bcf, 100%[i,j]	143	149	142	121	109	103	88	105	107	106	90	−4	5
Nitric acid, 100%[k]	7,887	7,225	6,734	7,631	7,726	6,768	7,390	9,093	9,231	8,916	7,934	9	0
Nitrogen gas, bcf, 100%[l,j]	719	676	617	665	661	560	483	490	479	427	379	6	7
Oxygen, bcf, 100%[l,j]	448	403	347	393	375	346	349	431	431	456	430	11	0
Phosphoric acid, 100% P_2O_5	11,729	10,685	9,578	10,518	11,370	9,767	8,253	9,958	10,848	10,318	9,637	10	2
Phosphorus[m]	352	344	364	359	386	366	361	426	432	460	441	2	−2
Sodium chlorate, 100%	277	289	267	259	295	323	291	297	312	269	265	−4	0
Sodium hydroxide, 100%	11,985	11,486	10,691	10,811	10,914	10,039	9,385	10,621	11,625	12,759	11,309	4	1
Sodium phosphate[n]	555	586	617	625	675	669	651	696	727	757	739	−5	−3
Sodium silicate[o]	813	952	791	737	685	710	664	771	805	813	829	−15	0
Sodium sulfate, 100%[p]	788	813	837	1,203	901	914	864	1,111	1,140	1,121	1,174	−3	−4
Sulfuric acid, 100%[q]	42,775	39,235	35,759	39,651	41,802	36,583	33,233	40,742	44,158	43,204	41,314	9	0
Titanium dioxide, 100%[r]	1,022	968	931	860	835	760	660	761	727	742	701	6	4
Urea	7,878	7,433	6,264	6,678	7,433	6,137	6,470	8,062	7,830	7,000	6,273	6	2

Note: bcf = billions of cubic feet. **a** Preliminary. **b** Commercial, 17% Al_2O_3; includes municipalities. **c** Synthetic anhydrous. **d** Excludes by-product ammonia liquor and ammonium sulfate. **e** Original solution. **f** Synthetic and noncoke by-product. **g** Includes quantities liquefied for use, storage, or shipment. **h** Includes anhydrous hydrochloric acid production. **i** High- and low-purity gas. **j** Liquid and gas; excludes amounts vented and used as fuel; and amounts produced in petroleum refineries for captive use. **k** Includes unspecified amounts of nitric acid produced but not withdrawn from the system. **l** Excludes amounts produced and consumed in making synthetic ammonia or ammonia derivatives. **m** Elemental; white (yellow), and red. **n** Tripolyphosphate (100% $Na_5P_3O_{10}$). **o** Soluble silicate glass (water glass); solid and liquid (anhydrous); excludes amounts produced and consumed in making meta-, ortho-, and sesquisilicates. **p** Anhydrous, high and low purity, and Glauber's salt. **q** Gross (new and fortified). **r** Composite and pure. **Sources:** Department of Commerce, International Trade Commission.

Man-made noncellulosic fibers output



MAN-MADE FIBERS: Output of polyolefins continues to set growth pace

Millions of lb	Production											Annual change	
	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1987–88	1978–88
NONCELLULOSIC FIBERS:													
Acrylic[a]	588	592	616	631	671	671	624	691	779	761	726	−1%	−2%
Nylon[b]	2669	2689	2514	2343	2412	2419	1927	2332	2358	2,720	2550	−1	0
Olefins[c]	1568	1494	1393	1249	997	906	723	785	748	759	692	5	9
Polyester	3681	3541	3305	3341	3392	3544	3196	4176	3989	4,178	3800	4	0
CELLULOSIC FIBERS:													
Acetate[d]	614	605	619	558	(199	229	196	261	316	324	308)	1	−4
Rayon					(421	401	388	509	490	606	597)		
GLASS FIBER	na	na	na	na	1394	1168	899	1,041	867	1,014	923	na	na
TOTAL[e]	**9120**	**8921**	**8447**	**8122**	**9486**	**9336**	**7926**	**9795**	**9547**	**10,362**	**9596**	**2%**	**nc**

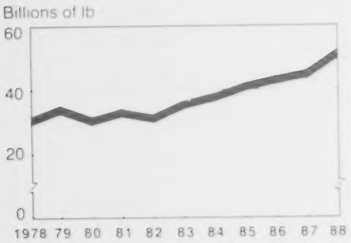
a Includes modacrylic. **b** Excludes aramid in 1983–87. **c** Includes olefin yarn and monofilaments and olefin and vinyon staple, tow, and fiberfill. **d** Includes diacetate and triacetate; excludes production for cigarette filters. **e** Totals for 1985, 1986, 1987, and 1988 exclude glass fiber. na = not available. nc = not comparable. **Source:** Textile Economics Bureau.

SYNTHETIC RUBBER: Good growth in output for all types last year

Thousands of metric tons	Production											Annual change	
	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1987–88	1978–88
Styrene-butadiene rubber	900	850	792	735	958	904	876	1032	1074	1378	1395	6%	−4%
Polybutadiene	407	371	336	330	359	333	288	342	311	397	378	10	1
Nitrile	76	69	59	53	67	55	45	66	63	75	73	10	0
Ethylene-propylene	263	254	230	215	215	175	123	178	144	175	174	4	4
Other[a]	679	638	596	505	556	468	498	404	423	509	453	6	4
TOTAL	**2325**	**2182**	**2013**	**1838**	**2155**	**1935**	**1830**	**2022**	**2015**	**2534**	**2473**	**7%**	**−1%**

a Includes butyl, polychloroprene, polyisoprene, silicone, and other synthetic elastomers. Some values are estimated. **Source:** Rubber Manufacturers Association

Plastics production

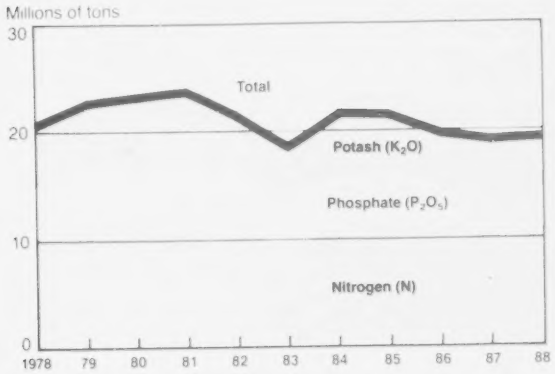


PLASTICS: Production of major resins made healthy gains in 1988

Millions of lb[a]	Production											Annual change	
	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1987–88	1978–88
THERMOSETTING RESINS													
Epoxy[b]	495	433	398	385	406	334	286	336	315	361	299	14%	4%
Polyester[c]	1,404	1,367	1,271	1,223	1,232	1,084	865	997	947	1,147	1,209	3	1
Urea	1,425	1,382	1,271	1,210	1,199	1,172	998	1,165	1,165	1,367	1,122	3	2
Melamine	207	212	173	192	210	180	158	179	167	200	202	−2	0
Phenolic[d]	3,066[e]	2,869[e]	2,735[e]	2,621[e]	2,502[e]	2,477[e]	2,006[e]	2,333[e]	1,499	1,781	1,617	7	nc
TOTAL	**6,597**	**6,263**	**5,848**	**5,631**	**5,549**	**5,247**	**4,313**	**5,010**	**4,093**	**4,856**	**4,449**	**5**	**nc**
THERMOPLASTIC RESINS													
Polyethylene													
Low density[f]	10,398	9,599	8,903	8,889	8,413	8,041	7,503	7,693	7,291	7,793	7,111	8	3
High density[g]	8,399	7,995	7,182	6,671	6,085	5,689	4,928	4,695	4,405	5,010	4,201	5	7
Polypropylene	7,272	6,647	5,812	5,139	4,940	4,433	3,477	3,955	3,648	3,841	3,074	9	8
Styrene-acrylonitrile	148	126	92	87	99	93	91	107	111	124	120	17	0
Polystyrene	5,130	4,780	4,470	4,054	3,838	3,570	3,191	3,621	3,521	4,005	3,823	7	2
Acrylonitrile-butadiene-styrene and other styrene polymers[h]	2,420	2,254	2,196	2,036	2,127	1,889	1,380	1,745	1,705	2,107	2,012	7	1
Polyamide, nylon type	566	507	465	399	396	321	228	312	274	327	275	12	6
Polyvinyl chloride and copolymers	8,350	7,971	7,256	6,772	6,760	6,067	5,326	5,707	5,470	6,119	5,723	5	3
Thermoplastic polyester	1,652	1,394	1,175	965	899	778	648	609	na	na	na	19	na
Other vinyl resins[i]	220	212	195	190	187	186	177	208	196	220	197	4	1
TOTAL	**44,555**	**41,485**	**37,746**	**35,202**	**33,744**	**31,067**	**26,949**	**28,652**	**26,621**	**29,546**	**26,536**	**7%**	**5%**

Note: Totals are for those products listed and exclude some small-volume plastics. a Dry-weight basis unless otherwise specified. b Unmodified. c Unsaturated. d Includes other tar acid resins. e Gross-weight basis. f Density 0.940 and below. g Density above 0.940. h Includes styrene-butadiene copolymers and other styrene-based polymers. i Includes polyvinyl butyral, polyvinyl formal, and polyvinylidene-chloride. **na** = not available. **nc** = not comparable. **Source:** Society of the Plastics Industry

Fertilizer consumption



Note: Years ending June 30. Sources: Department of Agriculture, Fertilizer Institute

FERTILIZERS:

Nutrient consumption rose slightly during 1988 crop year

Thousands of tons	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	Annual change 1987–88	Annual change 1978–88
Nitrogen (N)	10,475	10,349	10,424	11,493	11,092	9,127	10,983	11,924	11,407	10,742	9,965	1%	1%
Phosphates (P_2O_5)	4,112	4,013	4,178	4,658	4,901	4,138	4,814	5,434	5,432	5,606	5,096	2	−2
Potash (K_2O)	4,943	4,852	5,053	5,553	5,797	4,831	5,631	6,320	6,245	6,245	5,526	2	−1
Total	**19,530**	**19,214**	**19,655**	**21,704**	**21,790**	**18,096**	**21,428**	**23,678**	**23,083**	**22,565**	**20,587**	**2%**	**−1%**

Note: Years end June 30. Sources: Department of Agriculture, Fertilizer Institute

FERTILIZER PRODUCTION

Output of most products was substantially higher during 1988

Thousands of tons	1988	1987	1986	1985	1984	1983	Annual change 1978–88	Annual change 1983–88
NITROGEN PRODUCTS								
Ammonia	14,136	13,357	12,565	16,594	16,613	13,361	6%	1%
Ammonium nitrate	2,765	2,472	2,250	3,175	3,365	3,232	12	−3
Ammonium sulfate	2,260	2,153	2,058	2,343	2,078	1,969	5	3
Urea	4,501	4,253	3,564	5,975	4,889	4,112	6	2
Nitrogen solutions	6,999	5,988	5,945	7,928	7,999	6,385	17	2
PHOSPHATE PRODUCTS								
Diammonium phosphate	11,575	9,537	7,492	10,800	12,358	10,264	21	2
Monoammonium phosphate	1,818	1,679	1,416	1,641	1,654	1,423	8	5
Concentrated superphosphate	2,032	2,049	2,127	2,570	2,404	2,684	−1	−5
Phosphate rock	42,220	39,330	36,227	49,348	47,465	40,664	7	1
Phosphoric acid (P_2O_5)	10,234	8,903	8,085	9,837	10,899	9,182	15	2
POTASH PRODUCTS								
Potassium chloride	2,243	1,810	1,715	1,713	2,168	1,928	24	3

Note: Figures are based on Fertilizer Institute surveys and may not represent the entire industry. Source: Fertilizer Institute

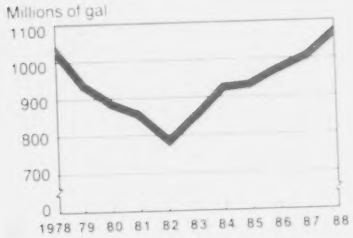
1 Production by the U.S. Chemical Industry

PESTICIDES: Overall production down sharply in 1987, despite increase for insecticides

Millions of lb	Production											Annual change	
	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1986–87	1977–87
Herbicides[a]	556	725	756	716	604	623	839	806	657	664	674	−23%	−2%
Insecticides[b]	379	342	370	350	306	379	448	506	617	605	570	11	−4
Fungicides	105	113	109	123	106	111	143	156	155	148	143	−7	−3
TOTAL	**1040**	**1180**	**1235**	**1189**	**1017**	**1113**	**1430**	**1468**	**1429**	**1416**	**1388**	−12%	−3%

a Includes plant growth regulators. b Includes rodenticides, soil conditioners, and fumigants. **Source:** International Trade Commission

Paints and coatings shipments



COATINGS: All categories move to record levels for decade

Millions of gal	Shipments										Annual change	
	1988*	1987*	1986	1985	1984	1983	1982	1981	1980	1979	1978	1987–88	1978–88
Architectural	532	510	501	477	457	433	374	417	439	472	na	4%	na
Product[b]	393	360	350	317	336	294	280	312	316	351	na	9	na
Special purpose	162	133	136	145	145	130	129	129	135	116	na	22	na
TOTAL	**1086**	**1004**	**987**	**939**	**938**	**857**	**783**	**858**	**890**	**939**	**1033**	8%	1%

a Preliminary. b For original equipment manufacturers. na = not available. **Source:** Department of Commerce

AEROSOLS: Strong volume gains for personal and automotive products in 1988

Millions of units	Production										Annual change	
	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1987–88	1978–88
Personal products	1100	964	952	879	832	747	628	645	637	772	729	14%	4%
Household products	650	640	635	630	603	586	556	575	580	653	628	2	0
Automotive and industrial products	440	379	375	342	337	303	286	302	310	300	275	16	5
Paints and finishes	331	307	297	290	307	300	295	313	310	302	309	8	1
Insect sprays	190	190	193	190	184	180	166	173	150	199	132	0	4
Food products	157	140	136	140	138	132	131	145	130	141	143	12	1
Animal products	8	22	22	15	16	19	19	14	15	18	15	−64	−6
Miscellaneous	31	80	18	23	15	15	13	28	30	14	a	−61	na
TOTAL	**2907**	**2722**	**2628**	**2509**	**2432**	**2282**	**2094**	**2195**	**2162**	**2399**	**2231**	7%	3%

a No. shown separately. na = not available. **Source:** Chemical Specialties Manufacturers Association

CHLOROFLUOROCARBONS: Production soared last year

Millions of lb	Production											Annual change	
	1988*	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1987–88	1978–88
Chlorodifluoromethane (F-22)	324	275	271	235	254	236	174	252	227	211	206	18%	5%
Dichlorodifluoromethane (F-12)	384	335	322	302	337	290	258	325	295	294	327	15	2
Trichlorofluoromethane (F-11)	223	198	202	176	185	215	140	163	158	167	194	13	1
All other fluorinated hydrocarbons[b]	na	354	344	306	337	279	na	na	na	202	189	na	na
TOTAL	**na**	**1162**	**1139**	**1019**	**1113**	**1020**	**na**	**na**	**na**	**874**	**916**	**na**	**na**

a Preliminary. b Includes other fluorohalogenated hydrocarbons. na = not available. **Source:** International Trade Commission

Another good year for chemical firms

If 1987 was a good year for the chemical industry, 1988 was even better. Company executives have every reason to be pleased with what happened at their firms.

Last year, to be sure, simply continued the economic momentum that has built up for the chemical industry since mid-decade in terms of almost all measures of performance. The improved results were spurred by many factors. Demand for chemical products soared once again, rising 13% from 1987. Prices, up 9%, rose to the point that many observers began to worry about substitution of other materials for their products—a fear that seems to have been unfounded thus far. Capacity utilization continued to climb, reaching an 87.3% level in 1988, in spite of some new plants and plant expansions coming on stream.

Export demand was the source of another fear that failed to materialize—that export demand was reaching its limit by the end of 1987 and would slow during last year. But government figures show that exports of chemicals and allied products increased about 22% last year compared with a gain of about 16% the previous year. Unfortunately, imports rose about as much, slowing the growth of the chemical trade surplus in 1988 from the more than 30% increase of the year before.

However, overall, the result was increasing sales and profits for chemical companies and profitability that has hit levels not seen in many years.

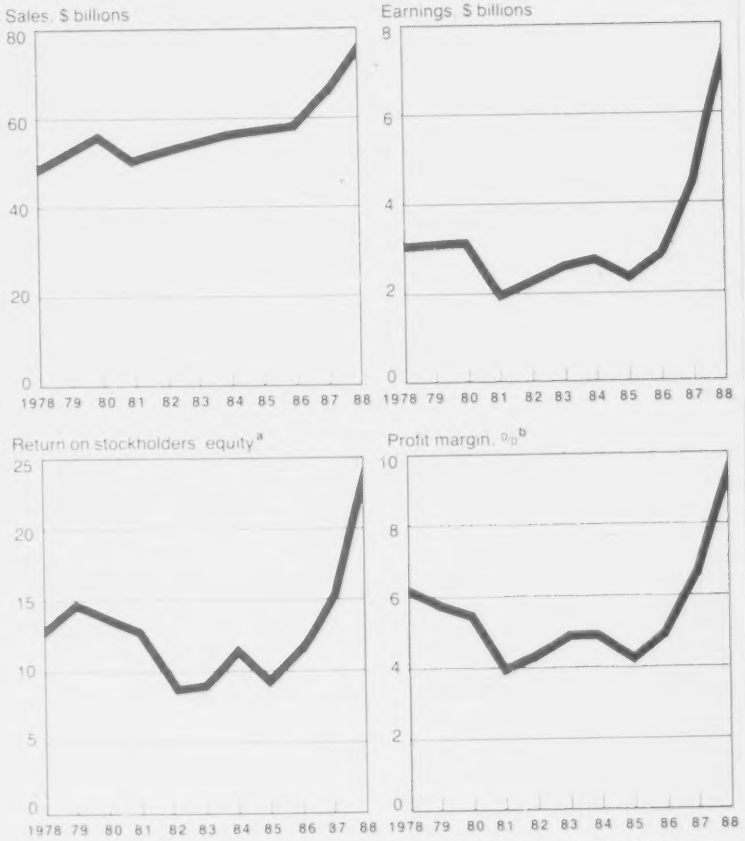
For the 30 chemical companies regularly tracked by C&EN, sales in 1988 increased 16%, following a 13% rise the year before. And in spite of an apparent slowing of the surge at year's end, after-tax earnings from continuing operations for the 30 companies rose 67%, compared with a 52% increase in 1987.

Because of continued efficiencies in chemical operations, plus the fact that prices for chemicals were rising faster than raw material costs in many cases, profitability soared for chemical firms. Average profit margin for the 30 companies jumped to 9.8% in 1988 from 6.8% in 1987 and 5.0% in 1986. Return on equity did even better, rising to a hardly believable average of 24.0% from 15.3% in 1987. In 1986, the average return on equity was 11.7%.

Overall, practically all measures of financial performance for chemical companies improved last year as firms reaped the benefits of a buoyant national business climate, low raw material costs, and low inflation overall relative to their own selling prices.

At the same time, many companies are still reaping the benefits in improved efficiency that stem from the drastic corporate restructuring and cost-cutting measures they undertook during the mid-1980s.

As earnings continue to soar, profitability has strengthened markedly in the chemical industry



Note: Historical data for 30 major chemical companies. a After-tax earnings as a percentage of year-end stockholders' equity. b After-tax earnings as a percentage of sales.

TOP 100 CHEMICAL PRODUCERS: Some major new entrants make the list for 1988

Rank 1988	Rank 1987		Chemical sales 1988 ($ millions)	Change from 1987	Chemical sales as % of total sales	Industry classification	Chemical operating profits[a] ($ millions)	Change from 1987	Chemical operating profits as % of total	Operating profit margin[b]	Identifiable chemical assets ($ millions)	Chemical assets as % of total assets	Operating return on chemical assets[c]
1	1	Du Pont	$14,717	12.8%	44.7%	Diversified	$2612	12.9%	61.3%	17.7%	$10,290	38.3%	25.4%
2	2	Dow Chemical	12,128	11.8	72.7	Basic chemicals	3655	89.4	88.0	30.1	10,792	66.5	33.9
3	3	Exxon	9,990	39.2	11.4	Petroleum	1863	71.4	21.2	18.6	6,731	9.1	27.7
4	4	Union Carbide	7,601[d]	23.1	91.3	Basic chemicals	1542	76.8	96.0	20.3	6,897	88.3	22.4
5	5	Monsanto	5,535	7.2	66.7	Basic chemicals	910	18.8	95.3	16.4	4,144	49.0	22.0
6	6	Hoechst Celanese	5,369	25.3	94.5	Basic chemicals	563	26.8	102.4	10.5	na	na	na
7	10	Occidental Petroleum	4,673	56.2	23.4	Petroleum	1050	163.8	191.6	22.5	5,258	25.3	20.0
8	7	BASF	4,536	18.9	88.0	Basic chemicals	na	na	na	na	na	na	na
9	9	Amoco	4,352	24.6	18.2	Petroleum	1022	45.2	28.1	23.5	2,920	9.9	35.0
10	11	Mobil	4,280	46.3	7.9	Petroleum	851	96.5	19.4	19.9	2,802	7.7	30.4
11	8	Shell Oil	4,006	12.0	19.0	Petroleum	746	24.3	34.1	18.6	3,822	14.1	19.5
12	14	General Electric	3,539[d]	28.6	7.1	Diversified	733	44.6	12.3	20.7	7,130	6.4	10.3
13	16	Chevron	3,204	23.6	11.6	Petroleum	616	55.2	19.0	19.2	2,101	6.7	29.3
14	13	W. R. Grace	3,131	12.1	54.1	Specialty chemicals	388	8.7	65.2	12.4	2,204	48.4	17.6
15	15	Eastman Kodak	3,033	16.7	17.8	Photo equipment	628	61.9	21.4	20.7	2,875	12.5	21.8
16	12	Allied-Signal	3,033	8.5	25.5	Diversified	377	23.2	53.6	12.4	1,839	18.4	20.5
17	19	Arco Chemical	2,700	38.3	100.0	Basic chemicals	722	81.4	100.0	26.7	2,548	100.0	28.3
18	17	Rohm & Haas	2,535	15.1	100.0	Basic chemicals	377	16.7	100.0	14.9	1,857	100.0	20.3
19	21	Phillips Petroleum	2,518	30.6	22.3	Petroleum	911	89.0	46.3	36.2	1,349	11.3	67.5
20	22	Air Products[e]	2,237	16.6	92.0	Basic chemicals	409	9.8	108.7	18.3	2,462	87.1	16.6
21	23	Quantum Chemical	2,219	18.3	76.0	Basic chemicals	711	104.7	93.6	32.1	1,465	50.4	48.6
22	18	American Cyanamid	2,167	10.5	47.2	Basic chemicals	214	11.0	38.9	9.9	1,519	49.4	14.1
23	20	Bayer USA	2,140	9.7	45.4	Diversified chemicals	118[f]	40.5	94.9	5.5	na	na	na
24	28	Ashland Oil[e]	2,090	27.2	25.5	Petroleum	102	13.3	24.7	4.9	754	17.7	13.5
25	25	B. F. Goodrich	2,074	19.1	85.8	Basic chemicals	308	46.5	88.5	14.8	1,358	79.9	22.7
26	32	Atlantic Richfield	1,903	38.0	10.4	Petroleum	na	na	na	na	na	na	na
27	26	Hercules	1,750	3.8	62.5	Basic chemicals	141	5.2	91.0	8.1	1,376	62.2	10.2
28	29	Texaco	1,711	7.8	5.1	Petroleum	379	193.8	11.8	22.2	1,029	3.9	36.8
28	—	Himont	1,711	46.8	100.0	Basic chemicals	526	69.1	100.0	30.7	1,044	100.0	50.3
30	31	Ethyl	1,674	19.1	61.6	Basic chemicals	309	20.1	70.4	18.5	1,141	22.7	27.1
31	43	BP America	1,507	59.8	9.8	Petroleum	na	na	na	na	na	na	na
32	33	Dow Corning	1,477	13.3	100.0	Specialty chemicals	151[f]	11.5	100.0	10.2	na	na	na
33	30	FMC	1,435	−3.6	43.7	Machinery	224	−7.7	58.4	15.6	1,234	54.1	18.1
34	37	National Starch	1,415	17.1	100.0	Specialty chemicals	200	14.1	100.0	14.1	1,110	100.0	18.0
35	34	Rhône-Poulenc	1,400	7.7	100.0	Specialty chemicals	na	na	na	na	na	na	na
36	35	Olin	1,366	10.9	59.2	Basic chemicals	105	6.1	58.3	7.7	953	49.1	11.0
37	40	Akzo	1,347	35.8	100.0	Basic chemicals	76	78.8	100.0	5.6	na	na	na
38	41	Aluminum Co. of America	1,215[d]	23.7	12.4	Nonferrous metals	419	569.2	24.1	34.5	2,577	24.5	16.3
39	38	Unocal	1,204	12.4	11.9	Petroleum	182	574.1	39.9	15.1	622	6.5	29.3
40	39	Huntsman Chemical	1,200	17.4	100.0	Basic chemicals	na	na	na	na	na	na	na
41	46	Freeport-McMoRan	1,130	31.5	58.1	Agrochemicals	198	85.9	39.3	17.5	894	24.0	22.1
42	42	PPG Industries	1,113	16.8	19.8	Glass products	255	82.1	27.6	22.9	1,048	20.3	24.3
43	28	Ciba-Geigy	1,098[g]	15.7	32.5	Specialty chemicals	na	na	na	na	na	na	na
44	—	IMC Fertilizer[h]	1,086	23.9	100.0	Agrochemicals	219	364.1	100.0	20.1	1,472	100.0	14.8
45	45	Aristech	1,065	15.9	100.0	Basic chemicals	196	63.2	100.0	18.4	676	100.0	29.0
46	58	Georgia Gulf	1,061	49.9	100.0	Basic chemicals	312	92.0	100.0	29.4	457	100.0	68.3
47	44	Lubrizol	1,036	10.2	92.0	Specialty chemicals	306	119.5	91.6	29.6	730	75.3	41.9
48	48	Pennwalt	1,024	21.0	100.0	Basic chemicals	135	31.5	100.0	13.2	738	100.0	18.3
49	47	NL Industries	1,007	17.2	100.0	Basic chemicals	261	24.8	100.0	25.9	841	100.0	31.0
50	59	Solvay America	1,000[d]	17.6	100.0	Basic chemicals	na	na	na	na	na	na	na

Rank 1988	Rank 1987		Chemical sales 1988 ($ millions)	Change from 1987	Chemical sales as % of total sales	Industry classification	Chemical operating profits[a] ($ millions)	Change from 1987	Chemical operating profits as % of total	Operating profit margin[b]	Identifiable chemical assets ($ millions)	Chemical assets as % of total assets	Operating return on chemical assets[c]
51	49	Nalco Chemical	$994	18.1%	100.0%	Specialty chemicals	$159	21.2%	100.0%	16.0%	$ 839	100.0%	18.9%
52	51	CF Industries	958	18.3	100.0	Agrochemicals	110	2461.4	100.0	11.5	991	100.0	11.1
53	36	International Minerals[h]	932	−23.2	100.0	Specialty chemicals	117	12.9	100.0	12.5	1,050	100.0	11.1
54	52	Cabot[e]	904	13.0	53.9	Basic chemicals	163	33.4	121.4	18.0	665	43.1	24.5
55	55	Morton Thiokol[h]	874	17.4	37.7	Diversified	149	14.7	52.2	17.0	795	41.4	18.7
56	60	Terra Chemicals	849	25.0	100.0	Agrochemicals	na	na	na	na	na	na	na
57	54	International Flavors	840	12.6	100.0	Specialty chemicals	209	14.0	100.0	24.9	882	100.0	23.7
58	53	Eli Lilly	798	6.6	19.6	Drugs	126	48.9	11.3	15.8	787	15.0	16.1
59	64	Vista Chemicals[e]	781	28.3	100.0	Basic chemicals	195	63.3	100.0	24.9	521	100.0	37.4
60	68	Farmland Industries	767	46.2	27.3	Agricultural supplies	75	5838.7	66.7	9.8	324	44.5	23.1
61	63	Witco	758[g]	21.5	47.8	Specialty chemicals	62	2.2	43.0	8.2	361	32.4	17.2
62	67	Uniroyal Chemical	734	24.3	100.0	Specialty chemicals	86	17.2	100.0	11.7	1,016	100.0	8.5
63	57	Engelhard	727	2.0	30.9	Diversified	107	22.7	85.5	14.8	880	62.3	12.2
64	—	Sterling Chemical	699	69.2	100.0	Basic chemicals	312	246.4	100.0	44.7	294	100.0	106.1
65	66	H. B. Fuller[i]	685	14.7	100.0	Specialty chemicals	46	−2.8	100.0	6.8	421	100.0	11.0
66	61	American Petrofina	682	1.7	27.7	Petroleum	281	38.2	113.7	41.1	360	15.5	77.9
67	65	Henkel	650	8.3	100.0	Specialty chemicals	na	na	na	na	na	na	na
68	72	Great Lakes Chemical	558	16.6	100.0	Specialty chemicals	143	68.7	100.0	25.7	664	100.0	21.6
69	—	Borden Chemicals	553	na	100.0	Basic chemicals	121	−41.8	100.0	21.9	605	100.0	20.0
70	76	GAF	545	26.3	56.7	Specialty chemicals	150	15.4	83.2	27.5	na	na	na
71	73	Kerr-McGee	518	11.6	19.3	Petroleum	102	43.7	43.8	19.7	671	22.3	15.2
72	69	Pfizer	512	−0.2	9.5	Drugs	49	−29.7	4.4	9.5	489	6.4	10.0
73	75	Tyler	485	11.3	75.3	Diversified	37	1.3	85.0	7.6	202	65.7	18.3
74	76	Merck	466	8.1	7.8	Drugs	62	6.6	3.3	13.2	426	7.0	14.4
75	79	Sun Co.	461	24.4	4.7	Petroleum	na	na	na	na	na	na	na
76	—	Hoffmann-La Roche	450	4.2	23.7	Drugs	na	na	na	na	na	na	na
77	78	Betz Laboratories	448	16.0	100.0	Specialty chemicals	na	na	na	na	na	na	na
78	80	Ferro	443	22.3	43.9	Specialty materials	18	−34.8	17.7	4.1	242	45.8	7.5
79	88	Dexter	424	9.7	51.3	Rubber products	26	−28.1	28.3	6.1	298	47.6	8.7
80	83	Loctite	417	23.4	100.0	Specialty chemicals	66	45.1	100.0	15.8	347	100.0	19.0
81	82	Union Camp	398	14.3	15.0	Diversified	30	42.8	6.0	7.5	294	9.5	10.2
82	85	Lonza	395	26.6	100.0	Specialty chemicals	na	na	na	na	na	na	na
83	86	Vulcan Materials	383	28.5	36.3	Nonmetallic minerals	66	102.3	31.9	17.3	na	na	na
84	87	Stepan	333	15.3	100.0	Specialty chemicals	21	6.9	100.0	6.2	186	100.0	11.1
85	90	Sigma-Aldrich	302	22.1	80.5	Specialty chemicals	77	20.7	86.9	25.5	314	87.4	24.5
86	89	Petrolite[j]	274	10.4	91.0	Specialty chemicals	21	−1.2	127.5	7.7	186	76.7	11.4
87	84	Chemed	270	−19.6	54.0	Specialty chemicals	33	−19.0	66.6	12.4	133	48.3	25.1
88	94	Georgia-Pacific	241	27.5	2.5	Wood products	na	na	na	na	na	na	na
89	95	First Mississippi	237	31.2	74.6	Agrochemicals	23	190.0	101.4	9.8	104	34.6	22.3
90	92	Crompton & Knowles	232	21.8	80.2	Specialty chemicals	26	33.5	71.3	11.4	159	77.1	16.7
91	—	Calgon Carbon	226	32.5	100.0	Basic chemicals	51	30.6	100.0	22.6	196	100.0	26.1
92	—	Sherex	200	na	100.0	Specialty chemicals	na	na	na	na	na	na	na
93	96	Mississippi Chemical	186	6.6	100.0	Farm cooperative	18	def	100.0	9.8	322	100.0	5.7
94	97	Quaker Chemical	167	12.9	100.0	Specialty chemicals	17	3.5	100.0	10.4	121	100.0	14.3
95	99	LeaRonal[k]	157	23.0	100.0	Specialty chemicals	14	12.4	100.0	9.0	88	100.0	15.9
96	—	Lawter International	126	12.3	100.0	Specialty chemicals	27	11.5	100.0	21.8	125	100.0	21.9
97	100	UGI	124	6.7	28.5	Natural gas	4	200.8	6.9	3.6	168	27.2	2.6
98	98	Agway	123	−7.6	3.4	Farm cooperative	na	na	na	na	na	na	na
99	—	Cambrex	120	11.5	100.0	Specialty chemicals	13	−4.3	100.0	10.5	na	na	na
100	—	Products Research	100	5.4	100.0	Specialty chemicals	17	−11.7	100.0	16.6	68	100.0	24.6

a Operating profit is sales less administrative expenses and costs of sales. b Operating profit from chemicals as a percentage of sales. c Chemical operating profit as a percentage of identifiable chemical assets. d Chemical sales include significant amounts of nonchemical products. e Fiscal year ends Sept. 30. f Chemical net income. g Does not include all chemical sales. h Fiscal year ends June 30. i Fiscal year ends Nov. 30. j Fiscal year ends Oct. 31. k For fiscal year ended Feb. 29, 1988. na = not available.

FINANCIAL ANALYSIS: Chemical firms generally improved their performance in 1988

		Profit margin[a]	Return on investment[b]	Debt as % debt plus equity	% total sales abroad[c]	% total assets abroad[d]	Sales per employee[e]	Dividends as % of net income	CAPITAL SPENDING[f] as % of sales	CAPITAL SPENDING[f] as % of net plant	R&D as % of sales	Sales as % of assets	Net plant as % of gross plant
SALES OVER $1 BILLION													
Air Products[g]	1988	8.8%	4.5%	34.4%	24.0%	29.9%	$183	28.2%	16.8%	19.9%	3.0%	81.1%	50.5%
	1987	7.5	2.5	35.0	22.0	26.7	176	31.6	15.1	16.8	2.7	78.9	33.6
American Cyanamid	1988	6.7	5.6	18.9	38.3	24.3	129	34.1	8.1	24.0	8.0	100.0	49.8
	1987	6.3	5.2	23.1	37.1	25.6	122	35.4	6.4	19.3	7.5	100.9	48.1
Cabot[g]	1988	3.6	2.8	34.5	36.8	9.6	322	40.5	10.1	20.3	1.7	108.6	52.1
	1987	2.8	1.9	27.2	39.2	20.6	279	65.1	5.7	10.2	2.4	97.3	52.9
Dow Chemical	1988	14.4	11.1	31.5	55.1	53.5	301	19.1	10.0	25.4	4.6	102.7	42.8
	1987	9.3	6.5	39.6	55.6	49.0	252	33.0	7.4	17.9	5.0	93.2	41.1
Ethyl	1988	11.5	11.0	35.0	21.5	3.6	193	22.5	7.5	21.0	2.9	38.3	49.3
	1987	11.2	11.8	38.8	22.0	9.0	172	25.5	8.0	20.5	2.9	86.8	50.4
Georgia Gulf	1988	18.3	38.3	14.2	na	na	776	8.6	2.4	14.8	na	231.9	69.0
	1987	13.0	25.0	22.6	na	na	712	6.0	1.4	8.3	na	229.2	65.2
B. F. Goodrich	1988	8.7	8.1	21.1	28.4	18.5	196	24.8	7.5	19.3	2.4	116.6	58.3
	1987	3.9	3.8	25.6	25.2	18.2	181	55.8	6.6	16.0	2.4	111.8	58.5
W. R. Grace	1988	4.0	3.8	49.3	37.0	28.6	127	52.1	7.2	20.6	2.1	109.0	49.8
	1987	3.1	2.7	45.5	37.9	27.8	115	84.0	5.4	14.3	2.4	100.9	47.4
Hercules	1988	4.3	3.1	17.3	22.6	13.3	123	77.1	9.0	21.6	2.7	84.3	49.6
	1987	9.9	6.8	18.2	21.3	12.0	116	36.8	7.6	19.1	2.7	77.1	49.9
International Minerals[h]	1988	7.1	7.1	25.9	17.3	14.5	213	41.0	5.5	18.2	4.4	82.0	71.1
	1987	0.9	0.5	40.7	13.7	13.7	127	276.7	3.8	4.9	3.6	67.3	55.7
Lubrizol	1988	11.7	10.1	7.7	53.6	35.1	234	48.0	4.9	18.3	5.8	115.1	40.8
	1987	8.0	6.7	8.3	55.2	35.9	210	59.3	4.1	14.1	6.1	107.9	42.2
Monsanto	1988	7.1	5.9	27.0	37.1	27.4	182	35.7	7.1	18.8	7.8	98.0	45.4
	1987	5.7	4.5	28.6	36.1	25.1	154	48.6	6.6	16.4	8.1	90.3	45.7
Olin	1988	4.2	3.3	33.8	10.1	9.2	141	36.7	6.4	18.4	2.5	119.0	37.0
	1987	4.0	2.9	35.9	7.3	7.7	137	47.4	6.0	15.8	3.2	114.5	36.2
PPG Industries	1988	8.3	6.8	27.2	30.0	28.8	155	30.0	7.3	14.9	4.0	109.0	55.1
	1987	7.3	5.7	29.7	29.2	28.9	141	34.9	8.2	15.9	4.4	103.9	56.5
Pennwalt	1988	4.7	3.7	40.2	34.8	27.7	205	63.3	4.6	13.0	3.0	107.8	44.5
	1987	4.7	3.8	31.5	28.4	29.7	127	58.6	4.8	12.7	3.9	109.7	47.7
Quantum Chemical	1988	12.3	11.0	144.0	na	na	na	17.4	11.4	25.5	na	100.5	67.4
	1987	5.6	5.0	41.0	na	na	na	50.6	6.0	11.2	na	99.4	67.8
Rohm & Haas	1988	9.1	7.4	19.3	42.8	30.2	204	29.1	13.3	36.1	6.2	113.1	45.3
	1987	8.9	7.2	19.7	41.5	30.0	183	30.3	10.1	30.4	6.4	112.7	41.6
Union Carbide	1988	8.0	5.6	55.6	30.8	36.9	189	23.4	8.1	15.2	1.9	98.6	49.0
	1987	3.4	2.1	69.7	30.9	36.4	160	84.1	7.3	11.6	2.3	87.6	50.3
Witco	1988	4.5	4.9	29.4	19.5	104.9	209	43.5	4.5	18.0	1.5	142.3	48.7
	1987	4.4	4.6	32.1	18.9	15.3	184	40.9	4.8	18.4	1.6	135.2	49.4
MEDIAN 1988		8.0	5.9	29.4	30.8	27.7	$195	34.1	7.5	19.3	3.0%	108.6%	49.6%
MEDIAN 1987		5.7	4.6	31.5	29.2	25.6	$166	47.4	6.4	15.9	3.2%	100.9%	49.4%

2 Finances of the U.S. Chemical Industry

		Profit margin[a]	Return on investment[b]	Debt as % debt plus equity	% total sales abroad[c]	% total assets abroad[d]	Sales per employee[e]	Dividends as % of net income	CAPITAL SPENDING[f] as % of sales	CAPITAL SPENDING[f] as % of net plant	R&D as % of sales	Sales as % of assets	Net plant as % of gross plant
SALES LESS THAN $1 BILLION													
Betz Laboratories	1988	10.8%	12.2%	0.0%	18.0%	20.0%	$142	50.8%	9.7%	28.4%	3.6%	140.5%	55.7%
	1987	10.5	11.3	0.0	16.8	19.7	136	57.4	6.6	19.0	3.7	134.5	52.4
Calgon Carbon	1988	13.0	13.6	18.3	34.4	35.1	na	7.1	7.1	18.7	2.0	115.2	77.7
	1987	10.3	10.6	20.0	25.4	29.6	na	8.3	2.6	5.9	1.7	111.4	81.2
Chemed	1988	4.7	8.3	44.8	12.7	11.1	80	77.3	3.3	24.0	0.7	137.4	58.0
	1987	6.0	10.4	29.1	13.1	11.3	71	70.1	2.6	18.4	0.9	129.0	55.9
Crompton & Knowles	1988	5.8	8.4	35.2	18.4	21.2	181	30.1	2.4	16.1	2.1	140.9	55.4
	1987	5.0	7.5	14.5	17.3	23.8	182	33.9	1.5	12.4	2.0	175.7	46.8
First Mississippi[h]	1988	10.2	5.7	1.8	25.1	na	na	14.8	19.0	36.2	na	96.3	35.2
	1987	6.7	3.5	26.7	24.0	na	na	25.8	7.0	12.8	na	94.1	34.3
H. B. Fuller[i]	1988	3.1	4.5	35.5	46.3	50.1	132	23.7	5.9	24.9	2.1	157.7	63.4
	1987	4.3	6.7	17.0	45.4	55.8	130	14.7	4.9	23.0	2.1	181.2	61.8
Great Lakes Chemical	1988	18.5	16.3	3.8	17.9	12.8	na	11.8	8.4	20.1	3.4	84.0	57.3
	1987	11.6	9.6	9.7	19.2	14.7	na	1.2	7.4	16.1	3.4	82.9	59.5
International Flavors	1988	15.3	12.1	0.0	70.1	48.0	201	47.1	4.8	17.6	5.9	95.2	55.1
	1987	14.3	10.3	0.0	70.3	50.4	181	46.9	4.9	16.8	6.0	85.3	55.7
Lawter International	1988	16.6	14.9	5.7	44.3	33.2	na	59.5	3.6	18.4	2.5	100.5	45.2
	1987	14.9	13.1	20.6	44.9	36.3	na	58.7	1.3	6.6	2.3	101.9	45.7
Loctite[h]	1988	10.0	11.4	16.1	58.4	62.2	127	23.7	3.5	19.8	3.5	120.2	57.1
	1987	9.1	9.6	5.5	54.3	57.4	107	27.0	4.6	21.9	3.6	111.3	59.1
Nalco Chemical	1988	10.7	10.8	17.4	27.6	20.4	185	47.6	6.2	19.8	3.7	118.5	48.0
	1987	9.5	9.0	13.0	26.1	21.8	166	58.8	6.8	18.8	4.2	112.7	50.1
Petrolite[j]	1988	4.3	3.7	2.2	30.2	34.3	na	97.5	6.8	19.6	4.1	124.7	44.7
	1987	4.3	3.3	1.4	31.8	32.8	na	107.6	6.8	19.4	4.3	112.2	45.0
Quaker Chemical	1988	7.0	8.9	5.7	40.6	30.7	170	29.6	3.2	16.1	5.5	137.6	52.9
	1987	7.0	8.2	6.0	40.7	31.3	153	32.7	2.5	11.3	5.7	124.7	54.5
Sigma-Aldrich	1988	15.0	13.9	6.0	18.0	15.4	117	14.4	9.5	29.8	na	104.3	68.6
	1987	13.7	12.8	7.3	16.8	16.1	105	16.9	6.8	21.2	na	106.9	68.7
Stepan	1988	4.0	4.6	40.5	na	na	324	19.8	6.1	19.5	3.9	179.4	47.9
	1987	3.8	4.1	42.6	na	na	288	21.8	8.9	26.0	3.9	167.3	49.5
Sterling Chemical[g]	1988	30.6	67.7	48.8	na	na	na	89.0	2.4	9.8	na	237.6	86.7
	1987	12.4	17.6	68.9	na	na	na	2.0	3.2	7.8	na	145.8	92.6
Vista Chemical[g]	1988	15.9	21.1	60.2	9.8	na	na	4.3	6.2	17.4	na	150.0	72.0
	1987	8.0	8.9	53.9	6.4	na	381	2.5	3.4	7.8	na	121.8	77.0
MEDIAN 1988		10.8%	10.8%	17.4	25.1%	21.2	$156	29.6%	6.1%	19.6%	3.5%	124.7%	55.7%
MEDIAN 1987		9.1%	9.6%	14.5	25.4%	29.6	$153	27.0	4.9%	16.8%	3.6%	112.7%	55.7%

Note: Net income is from continuing operations, excluding extraordinary and nonrecurring items where possible. a Net income as a percentage of sales. b Net income as a percentage of current assets plus gross plant. c Consolidated sales only. d Foreign identifiable assets as a percentage of total assets. e Thousands of dollars. f Actual spending on construction of new facilities and purchase of new equipment and land in consolidated businesses. g Fiscal year ended Sept. 30. h Fiscal year ended June 30. i Fiscal year ended Nov. 30. j Fiscal year ended Oct. 31. **na** = not available.

2 Finances of the U.S. Chemical Industry

Capital spending by U.S. chemical producers grew at an astonishing rate in 1988 compared with 1987, scoring the best year-to-year increase in the past 10 years, according to both the C&EN survey of 26 major chemical producers and the Department of Commerce's survey of chemical industry capital spending.

The increase in outlays for new plant and equipment for the 26 chemical makers surveyed by C&EN was 34%, while the much wider survey conducted by the Department of Commerce showed a 17% increase. If capital spending levels increase in 1989 as the Department of Commerce's survey indicates, chemical producers will boost spending another 11% this year.

Even as many debottlenecking projects for major commodity chemicals—such as propylene, ethylene, vinyl chloride, and acrylonitrile—have either come on stream or are about to do so, demand continues relatively strong. As a result, many producers seem to have abandoned their earlier cautious approach. Instead of just slating debottlenecking projects, they have announced new plant projects. However, whether the announcements presage another building boom reminiscent of the industry's binge in the 1970s or merely are being announced to discourage building by competitors remains to be seen. Best bet is that there is some truth in both views.

Among the 26 chemical producers in C&EN's survey who have increased their capital expenditures significantly above the 34% average are Quantum Chemical, Cabot, Crompton & Knowles, Dow Chemical, Chemed, and Rohm & Haas.

Perhaps because of the recent strength of the dollar, many chemical producers are planning increases in capital expenditures overseas. A Commerce Department survey in-

INDUSTRY CAPITAL SPENDING: 1989 will bring second big increase in a row for chemicals

$ Billions	1989[a]	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979
Chemicals	$ 21.31	$ 19.25	$ 16.42	$ 16.81	$ 16.44	$ 15.32	$ 12.96	$ 12.66	$ 13.11	$ 11.63	$ 9.81
Iron and steel	6.61	6.16	4.69	3.32	4.12	3.54	3.25	3.78	3.48	3.44	3.21
Nonferrous metals	3.04	2.77	2.16	1.93	1.88	2.13	1.74	1.90	2.51	2.13	1.65
Paper	15.21	11.23	9.01	8.77	8.59	7.21	5.92	5.60	6.11	6.52	5.24
Petroleum	19.32	19.93	17.12	17.92	26.71	25.53	23.14	26.39	25.98	19.57	15.24
Rubber	4.15	3.86	3.52	3.89	3.86	3.11	2.46	2.16	2.15	2.03	2.46
Stone, clay, glass	3.66	3.59	3.37	3.14	3.40	3.09	2.77	2.90	3.41	3.98	3.99
All manufacturing	178.66	165.70	145.90	142.69	153.48	138.82	116.20	120.68	126.54	112.33	95.92

a Estimate. **Source:** Department of Commerce

Chemical industry's backlog of unspent funds showed 50% increase last year

$ Billions	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978
Chemicals	$ 10.6	$ 7.0	$ 6.2	$ 8.0	$ 7.8	$ 7.5	$ 7.4	$ 9.4	$ 9.8	$ 8.5	$ 7.2
Iron and steel	2.7	1.4	0.5	1.1	2.1	2.2	2.7	5.4	3.9	4.5	4.0
Nonferrous metals	1.6	1.7	1.6	2.3	2.5	3.2	3.2	3.7	3.7	2.9	2.7
Paper	12.3	6.3	4.4	4.3	5.9	4.0	5.1	5.1	4.0	4.2	3.2
Petroleum	14.6	15.2	16.7	26.2	24.7	22.3	22.9	29.7	26.7	16.1	14.6
Rubber	2.8	1.7	1.9	3.1	1.6	1.1	1.0	0.9	1.0	0.9	0.9
Stone, clay, glass	2.8	2.4	1.8	2.0	2.2	1.5	1.6	1.9	2.0	2.3	2.4
All manufacturing	101.7	76.8	69.7	95.0	94.4	73.7	70.8	92.7	91.9	76.7	63.4

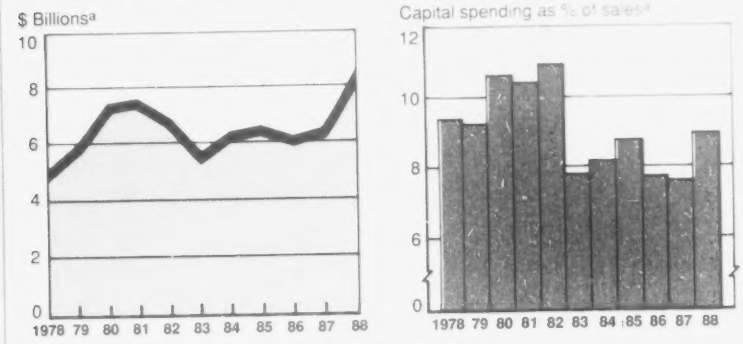
Note: Figures are for fourth quarter of each year. **Source:** Conference Board

Capital spending by chemical firms abroad is still on the upswing

$ Billions[a]	1989[b]	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979
Chemicals and allied products	$ 5.2	$ 4.4	$ 3.7	$ 3.1	$ 2.7	$ 2.4	$ 2.3	$ 2.8	$ 3.0	$ 3.0	$ 2.6
Metals, primary and fabricated	1.2	0.9	0.8	0.9	0.9	1.0	0.9	0.9	0.8	0.9	0.6
Petroleum	13.7	13.3	9.8	9.6	13.7	14.1	15.9	19.7	15.8	14.8	11.0
All manufacturing	24.5	20.8	17.2	16.4	14.9	13.6	13.6	16.8	19.2	19.5	15.4

a By majority-owned affiliates of U.S. companies. b Planned. **Source:** Department of Commerce

Last year's strength in chemical capital spending lifted it to the highest level relative to sales since 1982



a Worldwide data for 26 major chemical producers. **Source:** Company data

dicates a spending increase abroad this year by U.S. chemical companies of 18%. These investments will not only serve the companies' ambitions for increasing their share in a global market but also would boost U.S. companies' foreign currency earnings if their exports were to suffer should a stronger dollar ultimately make U.S. products more expensive for overseas buyers.

Despite the rise in expenditures directed toward capital projects, spending as a percentage of sales still lags historic highs. The spending increase in 1988 to 8.9% of sales is still below the 10.9% level of 1982.

CHEMICAL CAPITAL SPENDING: 1988 witnessed a sharp upsurge

$ Millions	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978
Air Products	$ 409	$ 323	$ 367	$ 392	$ 263	$ 246	$ 347	$ 323	$ 364	$ 246	$ 200
American Cyanamid	374	268	263	203	200	165	171	181	196	235	251
Cabot[a]	170	83	80	184	505	80	152	194	137	98	128
Chemed	15	9	9	7	9	5	4	4	4	6	3
Crompton & Knowles	7	4	4	3	3	2	3	7	10	8	5
Dow Chemical	1670	995	890	806	781	630	829	1176	1184	1268	1075
Du Pont[b]	2029	1674	1587	1515	1319	1276	1300	1420	1297	864	714
Ethyl	151	139	134	90	103	85	92	141	156	123	96
B. F. Goodrich	181	143	144	202	153	115	144	205	184	192	115
W. R. Grace	418	243	199	348	380	353	560	657	658	514	313
Great Lakes Chemical	47	35	18	21	29	20	29	47	21	18	9
Hercules	251	205	257	234	218	168	174	167	229	186	116
Loctite	14	15	9	11	6	10	11	13	14	9	6
Lubrizol	55	42	41	40	30	25	52	75	92	51	44
Monsanto	590	505	520	645	614	560	673	668	781	566	480
Nalco Chemical	62	57	64	60	53	41	56	59	35	39	34
Olin	147	115	128	154	165	123	129	186	172	161	163
PPG Industries	410	426	356	452	315	450	452	376	401	252	261
Pennwalt	47	55	54	90	87	70	76	53	53	66	61
Petrolite	20	19	25	24	11	9	24	15	17	12	7
Quaker Chemical	5	4	5	6	4	2	2	1	5	3	4
Quantum Chemical	334	154	102	76	116	71	66	44	49	58	106
Rohm & Haas	338	222	179	159	124	72	126	182	93	68	66
Stepan	20	26	14	19	12	10	16	12	9	14	14
Union Carbide	671	502	524	649	670	761	1179	1186	1129	831	688
Witco	72	69	60	76	85	55	54	83	73	49	51
TOTAL	**$8507**	**$6332**	**$6033**	**$6466**	**$6255**	**$5404**	**$6721**	**$7475**	**$7363**	**$5937**	**$5010**
ANNUAL CHANGE	**34%**	**5%**	**−7%**	**3%**	**16%**	**−20%**	**−10%**	**2%**	**24%**	**19%**	**−1%**

Note: Figures are for worldwide spending on construction, equipment, and land in consolidated businesses. Where possible, acquisition costs and investments in nonconsolidated businesses are excluded. a Includes acquisitions and investments. b Excludes Conoco. **Source:** Company data

SHIPMENTS: Chemicals outpaced all manufacturing by wide margin last year

$ Billions	1988[a]	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	Annual change 1987–88	Annual change 1978–88
All manufacturing industries	$2611.6	$2390.0	$2260.3	$2279.1	$2254.4	$2054.9	$1960.2	$2017.5	$1852.7	$1727.2	$1523.4	9%	6%
Chemicals and allied products	240.5	212.7	197.1	197.3	198.2	183.2	170.7	180.5	162.5	147.7	129.8	13	6
Industrial chemicals[b]	67.8	59.5	54.1	59.6	61.5	56.6	53.2	62.7	57.3	52.3	44.8	14	4
Drugs, soap, and toiletries	73.1	67.1	65.8	60.9	57.5	54.4	50.7	46.9	41.9	36.7	34.7	9	8
Petroleum and coal products	124.2	124.5	124.9	179.1	189.0	192.6	208.9	224.1	198.7	148.4	103.9	0	2
Rubber and plastic products, nec	91.1	80.5	73.4	71.3	69.5	60.3	55.4	53.2	47.3	46.8	43.2	13	8
Paper and allied products	124.2	110.3	97.9	93.4	94.8	84.6	79.9	80.2	72.8	65.2	57.0	13	8

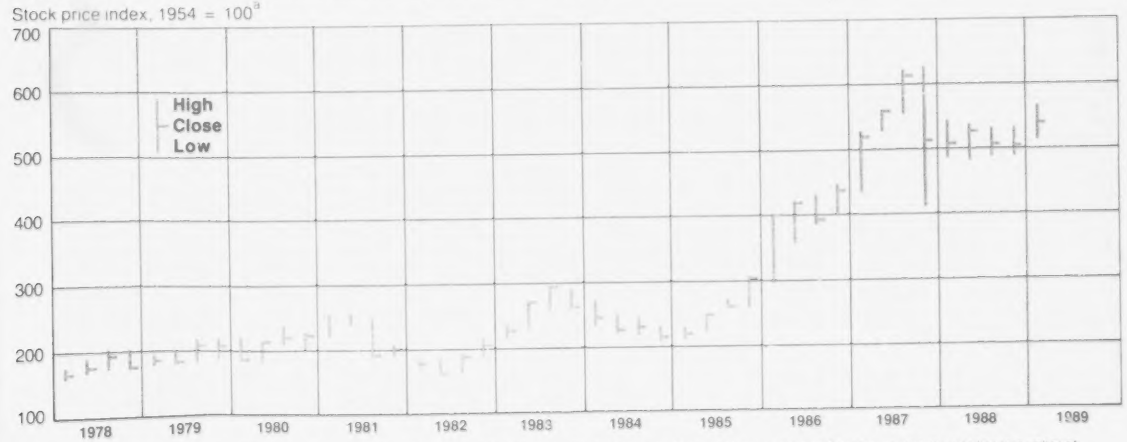
a Preliminary. b Excluding pigments. nec = not elsewhere classified. Source: Department of Commerce

PRICES: All chemical products rose, some steeply

Producer price indexes,[a] 1982 = 100	Annual average 1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	Annual change 1987–88	Annual change 1978–88
All commodities	106.9	102.8	100.2	103.1	103.7	101.3	100.0	98.0	89.8	78.7	69.9	4%	4%
Industrial commodities	106.3	102.6	99.9	103.7	103.3	101.1	100.0	97.4	88.0	75.7	67.0	4	5
Chemicals and allied products	116.3	106.4	102.5	103.7	102.9	100.2	100.0	98.4	89.1	76.1	68.0	9	6
Industrial chemicals	106.8	95.5	91.5	96.0	96.8	97.3	100.0	103.0	91.9	74.9	64.0	12	5
Prepared paint	112.2	108.1	107.0	105.3	103.7	100.7	100.0	95.0	89.5	77.8	73.1	4	4
Paint materials	115.7	107.3	104.4	109.5	108.2	100.3	100.0	98.5	89.9	79.2	69.8	8	5
Drugs and pharmaceuticals	148.4	139.1	129.9	122.2	114.2	107.7	100.0	92.1	83.1	75.9	70.5	7	8
Fats and oils, inedible	110.9	92.7	80.5	110.6	139.1	106.2	100.0	110.7	111.6	141.1	118.3	20	−1
Agricultural chemicals and chemical products	104.5	96.4	94.2	96.2	97.4	96.0	100.0	97.5	87.9	73.3	67.8	8	4
Plastic resins and materials	132.4	110.3	104.4	107.5	108.9	102.4	100.0	102.0	98.5	83.2	70.5	20	7
Other chemicals and allied products	111.9	107.0	105.8	105.2	102.7	101.3	100.0	94.1	83.1	71.0	67.3	5	5
Rubber and plastics products	109.3	103.0	101.9	101.9	102.2	100.8	100.0	96.4	90.1	80.5	72.4	6	4

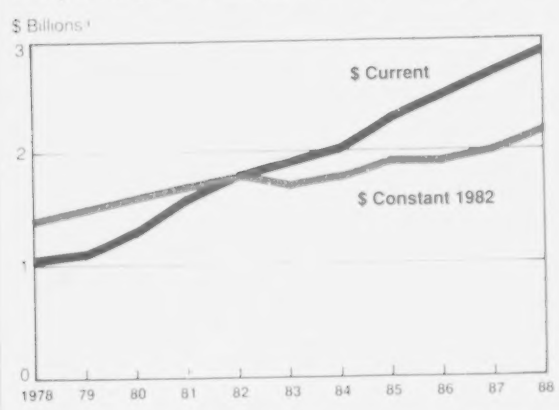
a Formerly called wholesale price indexes. Source: Department of Labor

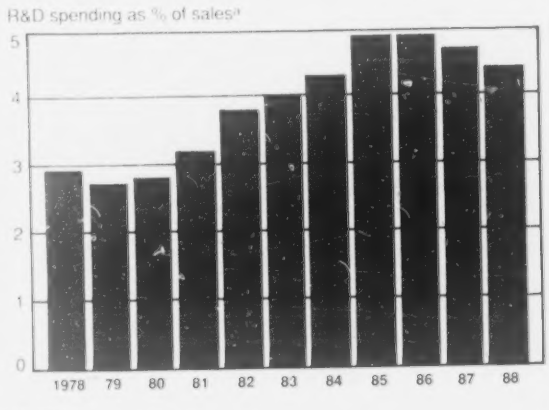
Prices of chemical stocks move up toward 1987 peak



a C&EN weighted stock price index of American Cyanamid, Dow Chemical, W.R. Grace, Hercules, Monsanto, Rohm & Haas, and Union Carbide, weighted according to number of shares outstanding for each company

Despite higher outlays, R&D spending by chemical firms has declined relative to sales





[a] R&D spending by "chemical" companies. Sources: Company data; Arthur D. Little; Columbia Laboratories

R&D SPENDING: Major chemical producers' budgets have more than doubled since 1980

$ Millions	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978
CHEMICAL COMPANIES											
Air Products	$ 72	$ 57	$ 61	$ 51	$ 44	$ 40	$ 37	$ 32	$ 30	$ 24	$ 23
American Cyanamid	365	314	278	251	232	208	185	166	148	130	108
Dow Chemical	772	670	605	547	507	492	460	404	314	269	232
Ethyl	59	50	47	47	40	39	39	37	34	29	25
W. R. Grace	119	107	94	92	81	73	64	57	45	42	37
Hercules	74	74	71	76	72	74	74	65	57	50	43
International Flavors	50	45	39	34	32	32	31	30	29	27	24
Lubrizol	65	62	51	44	33	37	36	33	28	23	21
Monsanto	648	615	596	470	370	290	264	233	208	161	136
Nalco	37	35	33	32	32	30	33	30	28	21	17
Olin	58	62	56	53	52	49	45	38	31	26	25
Pennwalt	31	45	45	39	36	33	31	27	24	22	23
Petrolite	12	12	12	12	12	13	10	8	7	6	5
PPG Industries	227	227	204	176	150	127	127	119	103	83	70
Rohm & Haas	156	142	133	124	109	100	92	77	67	54	49
Union Carbide	159	159	148	275	265	245	240	207	166	161	156
TOTAL	**$2904**	**$2676**	**$2473**	**$2323**	**$2067**	**$1882**	**$1768**	**$1563**	**$1319**	**$1128**	**$994**
ANNUAL CHANGE	**9%**	**8%**	**6%**	**12%**	**10%**	**6%**	**13%**	**18%**	**17%**	**13%**	**8%**
PHARMACEUTICAL & DIVERSIFIED COMPANIES											
Allied-Signal	$ 647	$ 667	$ 734	$ 470	$ 389	$ 383	$ 177	$ 152	$ 105	$ 70	$ 56
Du Pont	1319	1223	1156	1144	1097	966	879	718	591	509	461
Eastman Kodak	1147	992	1059	976	838	746	710	615	520	459	389
Eli Lilly	500	466	427	370	341	294	267	235	201	178	150
FMC	144	132	146	149	121	102	105	94	81	69	54
Merck & Co.	650	566	480	426	393	356	320	274	234	188	161
Morton Thiokol	45	40	38	34	28	21	7	6	6	5	4
Pfizer	473	401	336	287	255	230	199	179	162	139	117
Upjohn	380	356	314	284	247	218	185	162	139	122	109
TOTAL	**$5305**	**$4843**	**$4690**	**$4140**	**$3709**	**$3316**	**$2849**	**$2435**	**$2039**	**$1739**	**$1501**
ANNUAL CHANGE	**10%**	**3%**	**13%**	**12%**	**12%**	**16%**	**17%**	**19%**	**17%**	**16%**	**17%**

Note: Prior years not restated to reflect company revisions. **Source:** Company data

INDUSTRY BALANCE SHEET: Assets rise more than liabilities, swelling stockholders' stake

Industrial chemicals and synthetics

Assets	1988 ($ billions)	1987 ($ billions)	Change
Current assets			
Cash	$ 1.75	$ 1.72	2%
Short-term securities	2.01	1.95	3
Receivables	17.32	15.02	15
Inventories	14.54	12.98	12
Other current assets	4.38	3.88	13
Total	**40.00**	**35.55**	**13**
Fixed assets			
Depreciable fixed assets	88.74	85.84	3
Land and mineral rights	5.47	3.12	75
Less: accumulated depreciation and depletion	46.52	45.56	2
Net fixed assets	47.69	43.40	10
Other assets, including investments and intangibles	**32.91**	**30.98**	**6**
TOTAL ASSETS	**$120.60**	**$109.93**	**10%**

Liabilities and stockholders' equity	1988 ($ billions)	1987 ($ billions)	Change
Current liabilities			
Short-term debt	$ 4.39	$ 3.97	11%
Accounts payable	8.34	8.04	4
Accrued income taxes	1.66	1.92	−14
Current portion of long-term debt	1.78	1.52	17
Other current liabilities	12.07	10.85	11
Total	**28.24**	**26.30**	**7**
Long-term debt	**28.31**	**28.29**	**0**
Other liabilities, including deferred taxes and minority interest	**12.93**	**10.00**	**29**
TOTAL LIABILITIES	**69.48**	**64.59**	**8**
Stockholders' equity			
Capital stock and other capital	15.98	16.31	−2
Retained earnings	35.14	29.03	21
TOTAL STOCKHOLDERS' EQUITY	**51.12**	**45.34**	**13**
TOTAL LIABILITIES AND STOCKHOLDERS' EQUITY	**$120.60**	**$109.93**	**10%**

Source: Bureau of the Census

DEBT RATIOS: Down slightly last year for chemical firms as growth in debt slows

$ Billions	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978
INDUSTRIAL CHEMICALS AND SYNTHETICS											
Long-term debt	$28.3	$28.3	$20.8	$19.2	$18.1	$19.4	$22.0	$21.4	$16.8	$14.8	$13.6
Stockholders' equity	$51.1	$45.3	$41.6	$40.8	$46.5	$45.3	$45.9	$42.5	$39.8	$32.3	$29.3
Debt ratio[a]	35.6%	38.4%	33.4%	32.0%	28.0%	30.0%	32.4%	33.5%	29.6%	31.4%	31.8%
CHEMICALS AND ALLIED PRODUCTS											
Long-term debt	$57.6	$53.6	$46.8	$38.2	$33.8	$36.2	$38.2	$36.9	$28.3	$24.9	$32.5
Stockholders' equity	$117.8	$106.9	$100.8	$100.3	$100.3	$97.2	$95.3	$89.9	$79.5	$67.4	$60.8
Debt ratio[a]	32.8%	33.4%	31.7%	27.6%	25.2%	27.2%	28.6%	29.1%	26.3%	27.0%	27.9%
ALL MANUFACTURING											
Long-term debt	$531.5	$451.7	$407.5	$367.0	$324.2	$286.6	$293.1	$266.5	$236.2	$204.8	$182.0
Stockholders' equity	$976.5	$912.8	$878.1	$870.7	$883.6	$837.6	$783.0	$762.3	$699.7	$624.0	$560.8
Debt ratio[a]	35.2%	33.1%	31.7%	29.6%	26.8%	25.5%	27.2%	25.9%	25.2%	24.7%	24.5%

Note: Because of changes in accounting rules and industry classifications, numbers over the entire range of years are not strictly comparable. [a] Long-term debt as a percentage of long-term debt plus stockholders' equity. **Source:** Bureau of the Census

CASH FLOW: Profits are a bigger source, plant outlay a growing use of chemical company funds

$ Millions, % of total	1988		1987		1986		1985		1984	
SOURCES OF FUNDS										
Net income	$ 7,551	38.2%	$ 5,697	29.6%	$ 3,414	13.6%	$ 986	6.5%	$ 3,859	29.7%
Depreciation and depletion	5,561	28.1	5,284	27.5	5,117	20.4	5,010	32.8	4,710	36.2
Deferred taxes	311	1.6	311	1.6	568	2.3	−34	−0.2	507	3.9
Other internal sources	2,489	12.6	4,272	22.2	6,084	24.3	6,707	43.9	2,357	18.1
Long-term debt	3,624	18.3	2,949	15.3	8,773	35.0	2,356	15.4	1,441	11.1
Stock	236	1.2	732	3.8	1,091	4.4	264	1.7	136	1.0
TOTAL	**$19,772**	**100.0%**	**$19,245**	**100.0%**	**$25,047**	**100.0%**	**$15,289**	**100.0%**	**$13,009**	**100.0%**
APPLICATIONS OF FUNDS										
Dividends	$ 2,287	11.6%	$ 2,181	11.3%	$ 1,992	8.0%	$ 2,049	13.4%	$ 1,998	15.4%
Capital expenditures	8,991	45.5	6,437	33.5	5,986	23.9	6,500	42.5	6,400	49.2
Additions to working capital	594	3.0	2,879	15.0	−567	−2.3	49	0.3	−436	−3.4
Reduction of long-term debt	3,164	16.0	2,564	13.3	7,669	30.6	2,555	16.7	2,529	19.4
Other applications	4,736	23.9	5,184	26.9	9,966	39.8	4,137	27.1	2,518	19.4
TOTAL	**$19,772**	**100.0%**	**$19,245**	**100.0%**	**$25,047**	**100.0%**	**$15,289**	**100.0%**	**$13,009**	**100.0%**

Note: Data are totals for 12 major chemical producers: American Cyanamid, Dow Chemical, Du Pont, Ethyl (excludes insurance business), W. R. Grace, Hercules, Monsanto, Olin, Pennwalt, Quantum Chemical, Rohm & Haas, and Union Carbide. **Sources:** Company annual reports

2 Finances of the U.S. Chemical Industry

Dow Chemical netted more than $2.4 billion last year. That's more than any U.S. chemical company had ever earned before. It is not surprising, then, that a satisfied president Frank Popoff told company shareholders in Dow's annual report this spring that in 1988 "fundamentals in the chemical industry were the strongest in years."

Dow, to be sure, is not the only U.S. chemical producer to report rosy results for 1988. As the following compilation of the financial results of major companies in the industry clearly demonstrates, it was the exception that did not rack up sharply improved returns both on sales and stockholders' equity.

Some of the most sparkling results, moreover, were from some of the newest names in the industry—companies like Arco Chemical, Aristech, Georgia Gulf, Himont, and Vista Chemical. For them, all of whom have major stakes in commodity chemical product lines no longer in favor with many of their older competitors, the combination of vigorous demand, surging selling prices, and streamlined operations has proved extraordinarily profitable. Even IMC Fertilizer Group, a company formed in early 1988 as a spinoff of International Minerals & Chemical's long lackluster fertilizer business, reported a "memorable and rewarding initial year" in its first annual report last year, with earnings of $112 million, more than four times what its business netted the year before.

Explanation of table headings

Year. Data are for calendar year unless otherwise indicated.

Net sales. Gross sales, less discounts, allowances, and returns; generally excludes excise taxes and other operating income or revenues.

Net income. Net sales and other income, less operating costs, nonoperating charges, depreciation, depletion, interest expense, deferred charges, minority interest in income, and taxes. Nonrecurring or extraordinary credits and charges have been excluded in most cases, but these items are indicated by a footnote.

Total assets. Sum at year's end of current assets, investments, prepaid expenses, net plant and equipment, and other tangible assets. Excludes insofar as possible intangible assets including goodwill, value of patents and trademarks, and the like.

Current ratio. The ratio of current assets (cash, marketable securities, receivables, and inventories but excluding prepaid expenses) to total current liabilities.

Net plant and equipment. Value at year's end of fixed assets, less accumulated depreciation, amortization, and depletion.

Capital expenditures. Total spending during the year for new fixed assets, such as plant, equipment, and land, and for replacement and modernization of facilities.

Net worth. Equity at year's end of preferred and common stock holders, including value of capital stock, capital and earned surplus, and surplus reserves, as well as contingency and miscellaneous reserves for which no definite purpose is stated. Intangible assets are deducted insofar as possible.

Net income (breakdown). **Percent of sales:** net income divided by net sales. **Percent of net worth:** net income divided by tangible net worth. **Dollars per share:** net income, less preferred dividends, divided by the number of shares of common stock outstanding. All figures are adjusted for stock splits, but no adjustment has been made for earlier years as a result of stock dividends or for dilution that might result from the conversion of preferred stock or debt to common stock or the exercise of stock options outstanding.

Dividends per share. Cash dividends paid (or declared) on each share of common stock; excludes the value of stock dividends, which are indicated by a footnote.

Dividend yield. Dividends per share divided by the average of the high and low prices of the common stock during the calendar year.

Stock price range. High-low market prices of common stock during the calendar year, adjusted for stock splits but not for stock dividends.

Price-earnings ratio. Average of the high and low prices of the common stock during the calendar year divided by net income per share.

Year	Net sales	Net income	Total assets	Current ratio	Net plant and equipment	Capital expenditures	Net worth	NET INCOME: % of sales	NET INCOME: % of net worth	NET INCOME: $ per share	Dividends, $ per share	Dividend yield, % of price	Stock price range, $ per share	Price-earnings ratio
	Money figures in thousands of dollars unless otherwise indicated													
CHEMICALS														
Air Products & Chemicals														
1988[a]	$2,431,866	$213,747	$2,962,295	1.1	$2,061,642	$409,433	$1,235,027	8.8%	17.3%	$3.90	$1.10	2.4%	$53⅜–36½	11.5
1987[a]	2,132,176	159,688[b]	2,695,625	1.2	1,920,520	322,765	1,140,512	7.5	14.0	2.83[b]	0.90	2.2	53⅞–29	14.6
1986[a]	1,982,134	4,735[c]	2,700,151	1.4	1,829,122	366,563	1,094,562	0.2	0.4	0.08[c]	0.77	2.2	41⅝–29⅛	422.2
1985[a]	1,829,588	143,484[d]	2,539,545	1.1	1,782,267	392,176	1,109,068	7.8	12.9	2.38[d]	0.635	2.3	34⅛–22¼	11.9
American Cyanamid Co														
1988	$4,592,000	$305,600	$4,332,200	1.4	$1,556,800	$373,800	$1,801,100	6.7%	17.0%	$3.41	$1.16	2.4%	$ 56–41⅞	14.4
1987	4,166,100	264,000[e]	3,878,400	1.5	1,391,900	268,100	1,622,400	6.3	16.3	2.89	1.025	2.4	57–29	14.9
1986	3,815,900	202,500	3,482,400	1.7	1,267,700	262,500	1,536,000	5.3	13.2	2.18	0.95	2.6	44⅞–27⅛	16.5
1985	3,536,100	120,200[f]	3,383,400	2.0	1,126,900	202,600	1,623,000	3.4	7.4	1.25[f]	0.95	3.5	29⅜–24	21.4
Arco Chemical Co														
1988	$2,700,000	$494,000	$2,548,000	1.8	$1,078,000	$199,000	$1,375,000	18.3%	35.9%	$5.00	$0.85	2.8%	$ 38–23¼	6.1
1987[g]	1,952,000	257,000	2,534,000	1.3	984,000	295,000	1,116,000	13.2	23.0	2.58[h]	0.20	0.7	38¾–17	10.8
1986	1,541,000	143,000	1,450,000	2.6	752,000	167,000	952,000[i]	9.3	15.0	1.44[h]	—	—	—	—
1985	1,589,000	89,000	1,278,000	—	—	86,000	879,000[i]	5.6	10.1	—	—	—	—	—
Aristech Chemical Corp														
1988	$1,065,200	$164,500[j]	$ 676,100	1.8	$ 422,500	$ 55,800	$ 410,400	15.4%	40.1%	$6.62	$0.86	3.0%	$ 36–22¼	4.4
1987	918,800	69,700	551,200	2.5	299,700	43,700	362,700	7.6	19.2	2.71	0.54	1.9	39–16¾	10.3
1986[k]	750,800	47,600	476,100	1.9	286,300	15,600	309,700	6.3	15.4	1.70[k]	0.00	0.0	18⅝–17¾	10.7
1985	789,100	20,500	452,400	2.5	303,200	17,900	262,900[l]	2.6	7.8	0.65[k]	—	—	—	—

a Fiscal year ends Sept. 30. b Excludes extraordinary net loss on extinguishment of debt of $4.1 million ($0.07 per share). c Includes special charge for writedown of assets, revaluation of South African investment, and staff reduction program of $132.2 million ($2.25 per share) and for loss of investment tax credits of $7 million ($0.13 per share). d Includes special charges, before taxes, of $300,000. e From continuing operations, excludes net income from discontinued operations of $11.6 million ($0.13 per share) but includes gain on sale of fragrance and skin care businesses, before taxes, of $12.0 million ($0.13 per share). f From continuing operations, excludes net income and gain on sale of Formica Brand Products Group of $8.9 million ($0.09 per share). g Arco Chemical, previously a subsidiary of Atlantic Richfield Co., became an independent, publicly owned company on Oct. 5, 1987. h Pro forma. i Atlantic Richfield equity investment. j Excludes special credit for cumulative effect on prior years in accounting for income taxes of $23.7 million ($0.95 per share) but includes gain on sale of Houston, Tex., plant, before taxes, of $23.9 million. k Aristech Chemical, previously the USS Chemicals division of USX Corp., became an independent, publicly owned company on Dec. 4, 1986. l USX Corp. equity investment.

Year	Net sales	Net income	Total assets	Current ratio	Net plant and equipment	Capital expenditures	Net worth	NET INCOME % of sales	NET INCOME % of net worth	NET INCOME $ per share	Dividends, $ per share	Dividend yield, % of price	Stock price range, $ per share	Price-earnings ratio
	(Money figures in thousands of dollars unless otherwise indicated)													
Betz Laboratories														
1988	$ 447,580	$ 48,385	$ 307,862	1.9	$ 174,970	$ 43,505	$ 219,901	10.8%	22.0%	$ 3.15	$1.60	3.4%	$ 52½-41¼	14.9
1987	385,868	40,634	275,664	1.7	153,200	25,428	193,959	10.5	20.9	2.59	1.46	3.1	58¼-35	18.0
1986	344,377	35,544	267,681	2.3	144,053	22,750	202,104	10.3	17.6	2.23	1.36	3.4	44¾-35	17.9
1985	319,381	36,792	253,704	2.2	137,255	27,030	194,793	11.5	18.9	2.33	1.26	3.7	38¼-30¼	14.7
Cabot Corp.														
1988[a]	$ 1,676,588	$ 61,175[b]	$ 1,530,186	1.3	$ 838,909	$ 169,957	$ 594,295	3.6%	10.3%	$ 2.27[b]	$1.15	3.2%	$ 41¾-29⅛	15.6
1987[a]	1,424,041	39,235[c]	1,447,001	1.2	794,470	81,087	574,610	2.8	6.8	1.42[c]	0.92	2.5	49¼-25¼	26.2
1986[a]	1,309,315	73,061[d]	1,490,759	2.0	642,137	72,551	572,145	5.6	12.8	2.56[d]	0.92	3.1	35⅜-23⅜	11.5
1985[a]	1,407,515	71,290[e]	1,573,086	1.9	623,211	141,559	604,085	5.1	11.8	2.22[e]	0.92	3.4	33¾-20½	12.2
Chemed Corp.														
1988	$ 500,647	$ 20,649[f]	$ 268,496	1.7	$ 61,102	$ 14,641	$ 57,061	4.1%	36.2%	$ 2.23[f]	$1.72	5.1%	$ 38-29¾	15.2
1987	391,004	20,362	220,549	1.5	48,545	8,893	69,944	5.2	29.1	2.28	1.60	4.5	44⅛-26⅜	15.5
1986	359,476	6,830[g]	229,316	1.6	46,554	9,385	75,339	1.9	9.1	0.76[g]	1.56	4.4	40-30⅛	46.1
1985	372,677	21,858	197,615	1.7	42,092	7,874	58,234	6.6	37.5	2.49	1.52	5.1	33⅝-25¾	11.9
Crompton & Knowles Corp.														
1988	$ 289,787	$ 16,845[h]	$ 177,204	1.5	$ 43,685	$ 7,050	$ 53,483	5.8%	31.5%	$ 2.85[h]	$0.86	3.1%	$ 35¾-19⅞	9.8
1987	237,469	11,750	127,689	2.2	29,085	3,632	68,265	4.9	17.2	1.95	0.67	2.8	30¼-18	12.4
1986	213,242	8,923[i]	126,881	2.2	28,511	3,514	60,565	4.2	14.5	1.32[i]	0.63	4.0	19⅝-12¼	12.0
1985	231,225	7,575	120,076	2.5	30,376	3,362	63,839	3.3	11.9	1.10	0.60	5.3	13⅝-9¼	10.3
Dow Chemical Co.														
1988	$16,682,000	$2,410,000[j]	$15,548,000	1.9	$ 6,576,000	$1,267,000	$ 6,564,000	14.4%	36.7%	$12.82[j]	$2.45	2.9%	$ 94-76¾	6.7
1987	13,377,000	1,245,000[k]	13,871,000	1.7	5,551,000	995,000	5,284,000	9.3	23.6	6.50[k]	2.10	2.5	109⅝-58¾	13.0
1986	11,113,000	741,000[l]	11,939,000	1.6	5,347,000	890,000	4,865,000	6.7	15.2	3.87[l]	1.85	3.6	61¾-39⅞	13.1
1985	10,500,000	58,000	11,565,000	1.5	5,127,000	806,000	4,527,000	0.6	1.3	0.31	1.80	5.2	41⅞-27	111.1
E. I. du Pont de Nemours & Co.														
1988	$32,917,000	$2,190,000	$30,159,000	1.5	$17,221,000	$4,001,900	$15,020,000	6.7%	14.6%	$ 9.11	$3.70	4.4%	$ 92⅞-75¾	9.3
1987	30,468,000	1,786,000	27,604,000	1.5	15,854,000	3,035,900	13,639,000	5.9	13.1	7.39	3.30	3.2	131-75	13.9
1986	27,148,000	1,538,000	26,083,000	1.5	15,697,000	2,737,000	12,724,000	5.7	12.1	6.35	3.05	4.0	92½-59½	12.0
1985	29,483,000	1,118,000	25,108,000	1.6	15,195,000	3,046,000	12,627,000	3.8	8.9	4.61	3.00	5.1	60⅜-47⅝	12.7
Ethyl Corp.														
1988	$ 2,011,487	$ 231,016	$ 5,107,817[m]	2.5	$ 719,551	$ 151,116	$ 986,289	11.5%	23.4%	$ 1.91	$0.45	2.2%	$ 24⅛-17¼	10.8
1987	1,720,338	193,319	1,875,614	2.2	674,075	138,481	852,799	11.2	22.7	1.57	0.40	1.7	32¼-15	15.0
1986	1,579,254	177,734	1,567,825	2.1	594,238	133,700	895,790	11.3	19.8	1.40	0.335	1.8	22¾-13½	12.9
1985	1,547,034	117,146[n]	1,509,988	2.0	557,256	89,512	754,853	7.6	15.5	0.92	0.285	2.5	15¼-7⅞	12.6
Ferro Corp.														
1988	$ 1,008,990	$ 46,620	$ 574,943	1.7	$ 197,222	$ 49,308	$ 282,137	4.6%	16.5%	$ 3.40	$0.70	2.3%	$ 40¾-21	9.1
1987	871,088	31,687	521,314	1.7	171,889	30,674	249,039	3.6	12.7	2.30	0.67	2.7	31¼-17½	10.6
1986	725,241	24,082	443,801	1.9	153,712	23,162	217,750	3.3	11.1	1.77	0.60	3.4	20⅝-15⅛	10.1
1985	651,071	11,163[o]	391,133	2.0	145,651	26,451	193,850	1.7	5.6	0.83[o]	0.60	3.9	18½-12⅛	18.4
First Mississippi Corp.														
1988[p]	$ 318,086	$ 32,475	$ 325,339	1.5	$ 166,966	$ 60,381	$ 181,447	10.2%	17.9%	$ 1.61	$0.24	1.6%	$ 18⅜-12	9.4
1987[p]	278,946	18,610	276,638	1.8	152,671	19,527	138,882	6.7	13.4	0.93	0.24	1.9	19⅛-6½	13.8
1986[p]	268,898	(28,110)[q]	287,562	1.6	155,266	31,635	125,521	—	—	(1.42)[q]	0.24	3.6	8⅛-5¼	—
1985[p]	273,185	18,239[r]	379,587	1.5	234,574	63,257	165,339	6.7	10.1	0.90[r]	0.24	2.6	11⅝-6⅝	10.1
Georgia Gulf Corp.														
1988	$ 1,060,612	$ 193,604	$ 437,083	2.0	$ 169,256	$ 25,062	$ 235,839	18.3%	82.1%	$ 6.75	$0.65	2.0%	$ 39⅞-24⅜	4.8
1987	707,453	91,736[s]	308,609	1.7	119,984	9,931	142,546	13.0	64.4	3.15[s]	0.20	0.9	34½-9⅞	7.1
1986	583,255	39,123	264,632	2.0	119,116	7,428	77,956	6.7	50.2	1.20	0.00	0.0	10-9¾	8.2
1985	613,537	36,431	292,142	1.1	135,007	6,177	36,289	5.9	100.4	1.11	0.00	—	—	—
B. F. Goodrich Co.														
1988	$ 2,416,700	$ 209,900[t]	$ 1,987,300	1.9	$ 934,400	$ 180,500	$ 1,080,200	8.7%	19.4%	$ 7.99[t]	$1.72	3.5%	$ 60¾-37½	6.1
1987	2,168,000	83,900[u]	1,905,800	1.4	898,200	142,600	972,600	3.9	8.6	3.17[u]	1.56	3.4	65-27⅜	14.6
1986	2,553,300	12,900[v]	1,786,700	1.4	865,200	144,000	799,200	0.5	1.6	0.46[v]	1.56	3.9	47⅞-32⅛	87.0
1985	3,200,500	(316,800)[w]	2,227,400	1.1	1,043,900	202,300	675,800	—	—	(14.11)[w]	1.56	5.0	35-25¾	—

a Fiscal year ends Sept. 30. **b** Excludes extraordinary net charge on early retirement of debt of $800,000 ($0.03 per share). **c** Excludes extraordinary net charge on early retirement of debt of $10.5 million ($0.38 per share). **d** Excludes extraordinary net charge on early retirement of debt of $2.0 million ($0.07 per share). **e** From continuing operations; excludes net loss from discontinued operations of $12.7 million ($0.39 per share) and provision for net loss on disposal of discontinued operations of $145.0 million ($4.53 per share). **f** From continuing operations; excludes net income from discontinued operations, extraordinary gain on termination of pension plan, and cumulative effect of changes in accounting principles of $3.5 million ($0.37 per share). **g** From continuing operations; excludes net income and gain on sale of discontinued Vestal Laboratories operations of $30.0 million ($3.36 per share) and extraordinary gain on termination of pension plan of $811,000 ($0.09 per share). **h** From continuing operations; excludes net loss from operations and on disposal of maintenance chemical business of $1.5 million ($0.25 per share). **i** From continuing operations; excludes net income and charge for discontinued Kem operations of $7.9 million ($1.24 per share). **j** Excludes net loss on early extinguishment of debt of $12 million ($0.06 per share). **k** Excludes net loss on early extinguishment of debt of $5 million ($0.03 per share). **l** Excludes net loss on early extinguishment of debt of $9 million ($0.05 per share). **m** Includes total assets of insurance business, previously carried as net investment in the business. **n** Includes net charge for plant shutdown and write-off costs of $20.0 million. **o** Excludes net loss on sale of Productol Chemical division of $2.3 million ($0.17 per share). **p** Fiscal year ends June 30. **q** Net loss. **r** Excludes net gain on disposal of FirstMiss subsidiary of $900,000 ($0.04 per share). **s** Excludes extraordinary net charge on retirement of debt of $9.9 million ($0.34 per share). **t** From continuing operations; excludes net loss from discontinued operations of $16.9 million ($0.68 per share) and net gain from cumulative effect of change in accounting for income taxes of $2.7 million ($0.11 per share). **u** From continuing operations; excludes net loss from discontinued operations of $4.7 million ($0.20 per share) and extraordinary net income of $25.8 million ($1.09 per share). **v** Excludes extraordinary net income of $19.8 million ($0.86 per share). **w** From continuing operations; excludes net loss from discontinued operations of $37.8 million ($1.68 per share).

2 Finances of the U.S. Chemical Industry

Year	Net sales	Net income	Total assets	Current ratio	Net plant and equipment	Capital expenditures	Net worth	NET INCOME: % of sales	NET INCOME: % of net worth	NET INCOME: $ per share	Dividends, $ per share	Dividend yield, % of price	Stock price range, $ per share	Price-earnings ratio
						(Money figures in thousands of dollars unless otherwise indicated)								
W. R. Grace & Co.														
1988	$5,786,100	$192,000[a]	$5,095,200	1.3	$2,028,300	$418,100	$1,336,000	3.3%	14.4%	$2.26[a]	$1.40	5.2%	$29⅞–23½	11.8
1987	4,515,400	141,900[a]	4,361,500	1.4	1,701,000	242,500	1,351,200	3.1	10.5	1.67[b]	1.40	5.0	37⅜–19⅞	16.9
1986	3,725,700	(375,400)[c,d]	3,993,000	1.3	1,579,000	199,100	1,204,400	—	—	(4.47)[c,d]	1.40	5.3	30¾–22⅝	—
1985	5,193,000	127,800[e]	5,287,800	1.9	2,596,000	348,000	2,271,400	2.5	5.6	1.22[e]	1.40	6.6	24¾–17¾	17.3
Great Lakes Chemical Corp.														
1988	$ 557,770	$103,288	$ 612,242	1.7	$ 234,405	$ 47,017	$ 430,629	18.5%	24.0	$5.93	$0.68	1.2%	$65⅞–48⅝	9.7
1987	478,386	55,536	523,365	1.8	218,403	35,186	338,880	11.6	16.4	3.34	0.60	1.1	77–35⅞	16.9
1986	300,329	26,817	447,840	2.3	209,425	18,327	172,538	8.9	15.5	1.79	0.52	1.4	44½–30⅞	21.1
1985	276,932	28,818	314,423	2.2	137,710	21,344	186,718	10.4	15.4	1.93	0.44	1.2	44¼–31¼	19.6
Hercules														
1988	$2,802,072	$120,435	$3,325,294	2.8	$1,164,102	$251,043	$2,044,533	4.3%	5.9%	$2.55	$2.00	4.1%	$ 54–42⅝	18.9
1987	2,693,003	208,000[f]	3,492,077	3.6	1,075,389	205,037	2,189,867	7.7	9.5	4.02[f]	1.64	3.2	73½–40	14.1
1986	2,615,110	206,200[g]	2,914,319	2.6	1,152,141	256,913	1,703,151	7.8	12.1	3.66[g]	1.72	3.5	60–37	13.3
1985	2,587,213	133,161[h]	2,658,822	2.5	1,000,212	234,240	1,474,201	5.1	9.0	2.40	1.60	4.5	40¾–31⅛	15.0
Himont														
1988[i]	$1,710,780	$372,897	$1,882,258	3.4	$515,029	$168,306	$1,335,385	21.8%	27.9%	$5.71	$1.20	3.2%	$ 47–29	6.7
1987[i,j]	1,165,031	226,906	1,487,040	4.6	393,658	85,074	1,046,845	19.5	21.7	3.77	0.34	0.9	54¼–23	10.2
1986[i]	980,909	97,334	910,032	1.6	379,225	115,250	450,622	9.9	21.6	2.17	3.65[k]	—	—	—
1985[i]	910,503	52,800	689,291	2.5	298,012	52,569	383,457	5.8	13.8	1.38	0.34	—	—	—
IMC Fertilizer Group														
1988[l,m]	$1,085,600	$111,700	$1,472,100	1.6	$780,000	$26,300	$ 676,100	10.3%	16.5%	$3.88	$0.37	1.1%	$45⅛–22½	8.7
1987[l]	876,200	26,600	1,332,200	1.7	841,600	110,400	1,004,300	3.0	2.6	0.10	—	—	—	—
1986[l]	866,000	(34,700)[n]	1,242,500	2.2	—	52,000	1,028,800	—	—	—	—	—	—	—
1985[l]	1,060,900	83,900	1,347,200	2.3	—	59,500	1,124,800	7.9	7.5	—	—	—	—	—
International Flavors & Fragrances														
1988	$ 839,545	$128,684	$ 882,333	5.0	$ 228,152	$ 40,812	$ 695,433	15.3%	18.5%	$3.40	$1.60	3.3%	$54½–43⅛	14.4
1987	745,861	107,017	874,554	4.2	219,305	36,946	659,908	14.3	16.2	2.83	1.24	2.6	57¾–37¼	16.8
1986	520,679	85,683	672,616	4.6	186,891	26,771	521,475	13.8	16.4	2.29	1.16	2.8	48⅞–34½	18.2
1985	501,046	69,698	559,855	4.2	159,298	22,134	426,986	13.9	16.3	1.89	1.12	3.4	40–26	17.5
International Minerals & Chemical Corp.														
1988[i]	$1,470,600	$103,900[e]	$1,588,900	2.0	$ 627,400	$ 81,200	$ 822,800	7.1%	12.6%	$3.30[e]	$1.00	2.3%	$51½–37¼	13.4
1987[i]	1,637,500	14,600[o]	2,242,400	1.4	2,292,500	62,500	877,200	0.9	1.7	0.08[o]	1.00	2.5	53–26½	496.9
1986[i]	1,177,700	(79,600)[d,p]	2,225,200	2.2	2,170,700	93,900	792,400	—	—	(2.96)[d,p]	1.80	5.9	36¼–25	—
1985[i]	1,627,300	119,600	1,957,200	2.0	2,144,300	116,000	1,092,000	7.3	11.0	4.39	2.60	6.6	44–34¼	8.9
Lawter International														
1988	$ 125,818	$ 20,851	$ 125,210	3.7	$ 24,546	$ 4,524	$ 79,521	16.6%	26.2%	$0.88	$0.52	4.2%	$14⅛–10¾	14.1
1987	112,018	16,701	109,917	4.3	22,603	1,528	69,458	14.9	24.0	0.71	0.42	3.5	15⅝–8½	17.0
1986	103,515	12,945	93,392	3.7	22,447	1,613	55,191	12.5	23.5	0.56	0.42	3.9	13–8⅝	19.5
1985	96,769	(5,413)[d,q]	84,039	3.4	22,702	3,179	47,588	—	—	(0.23)[d,q]	0.42	4.7	10⅛–7¾	—
Loctite Corp.														
1988[i]	$ 416,880	$ 41,850	$ 328,833	2.4	$ 73,008	$ 14,466	$ 187,100	10.0%	22.4%	$2.32	$0.61	1.8%	$ 39–27	14.2
1987[i]	337,802	30,665	289,367	1.9	70,802	15,470	167,561	9.1	18.3	1.69	0.47	1.7	36–19	16.3
1986[i]	266,788	23,173	240,565	2.2	57,711	9,299	150,163	8.7	15.4	1.28	0.41	2.0	24⅞–16⅝	16.2
1985[i]	231,479	20,443	215,482	1.9	49,793	11,278	121,918	8.8	16.8	1.12	0.40	2.5	18½–13½	14.3
Lubrizol Corp.														
1988	$1,117,493	$131,206[r]	$ 970,671	3.0	$ 298,670	$ 54,611	$ 664,308	11.7%	19.8%	$3.40[r]	$1.30	3.6%	$42⅜–30	10.6
1987	1,013,430	81,335	939,378	3.0	297,573	42,040	621,633	8.0	13.1	2.06	1.22	3.6	41¾–25¼	16.3
1986	976,776	78,185	877,907	2.7	289,078	40,460	572,679	8.0	13.7	1.97	1.17	3.9	35⅛–25⅝	15.4
1985	903,403	60,224	854,445	2.4	290,298	39,498	519,298	6.7	11.6	1.49	1.16	4.8	28⅛–19¾	16.3
Monsanto Co.														
1988	$8,293,000	$591,000	$6,671,000	1.3	$3,146,000	$590,000	$2,010,000	7.1%	29.4%	$8.27	$2.95	3.6%	$92⅜–73½	10.0
1987	7,639,000	436,000	6,502,000	1.4	3,076,000	505,000	1,948,000	5.7	22.4	5.63	2.75	3.5	100¼–57	14.0
1986	6,879,000	433,000	6,125,000	1.4	2,913,000	510,000	1,637,000	6.3	26.5	5.55	2.575	4.1	81½–44¾	11.4
1985	6,747,000	(128,000)[d,s]	6,678,000	1.1	3,034,000	645,000	1,208,000	—	—	(1.67)[d,s]	2.45	5.1	55⅝–40⅝	—
Morton Thiokol														
1988[i]	$2,316,400	$159,400[t]	$1,670,800	1.8	$ 760,300	$163,000	$ 815,900	6.9%	19.5%	$3.33[t]	$0.82	2.0%	$ 46–35⅝	12.3
1987[i]	1,987,300	138,000	1,426,400	1.5	655,900	130,400	700,400	6.9	19.7	2.90	0.745	1.7	54¾–31	14.8
1986[i]	1,949,900	132,900	1,225,000	1.7	593,900	95,700	629,900	6.8	21.1	2.80	0.685	1.9	42½–30	12.9
1985[i]	1,832,300	119,500[e]	1,173,900	1.8	560,700	117,000	510,500	6.5	23.4	2.44[e]	0.63	1.9	40½–26	13.6

a From continuing operations, excludes net income from discontinued operations and gain from cumulative effect of accounting change of $41.6 million ($0.49 per share). b From continuing operations, excludes net income from discontinued operations of $16.6 million ($0.22 per share) and tax benefit of operating loss carryforward of $12.6 million ($0.14 per share). c From continuing operations, includes asset write-downs and reserves, before taxes, of $368.8 million but excludes net loss from discontinued operations of $96.9 million ($1.15 per share). d Net loss. e From continuing operations, excludes net income from discontinued retail operations of $19.1 million ($0.18 per share). f Excludes net gain on disposal of Himont and other net gains and charges of $6.13.7 million ($1.72 per share). g Excludes nonrecurring net gains from sale of investments and businesses and nonrecurring net costs of $20.5 million ($0.36 per share). h Includes pretax gain on disposal of assets of $16.4 million. i Fiscal year ends Oct. 31. j Himont, previously jointly owned by Hercules and Montedison, became a publicly owned company on Feb. 20. k Includes distribution to Hercules and Montedison of $2.36 per share. l Fiscal year ends June 30. m IMC Fertilizer Group, previously the fertilizer business group of International Minerals & Chemical Corp., became an independent, privately owned company on Feb. 2. n From continuing operations, excludes net loss on disposal of discontinued operations of $5.0 million ($0.19 per share) and extraordinary net credit of $16.2 million ($0.55 per share). o From continuing operations, excludes net income on disposal of discontinued operations of $11.3 million ($0.41 per share) and extraordinary net charge of $4.8 million ($0.18 per share). p From continuing operations, excludes net loss from and net provision for loss on disposal of discontinued gas and oil and industrial products operations of $137.4 million ($5.08 per share). q Includes one-time tax provision for future repatriation of foreign earnings of $14.0 million ($0.60 per share). r Includes credit for patent litigation settlement, before taxes, of $61.2 million but excludes net credit for cumulative effect of change in accounting for income taxes of $8.8 million ($0.22 per share). s Includes special charge for restructuring costs, before taxes, of $557 million but excludes net gain from repayment of debt of $36 million ($0.40 per share). t Excludes net charge for cumulative effect of change in accounting for income taxes of $14.1 million ($0.29 per share). u From continuing operations, excludes net income from discontinued Texsize Division operations of $3.3 million ($0.06 per share) and net gain on sale of the division of $75.1 million ($1.51 per share).

Year	Net sales	Net income	Total assets	Current ratio	Net plant and equipment	Capital expenditures	Net worth	NET INCOME % of sales	NET INCOME % of net worth	NET INCOME $ per share	Dividends, $ per share	Dividend yield, % of price	Stock price range, $ per share	Price-earnings ratio
					(Money figures in thousands of dollars unless otherwise indicated)									
NL Industries														
1988[a]	$1,007,036	$134,236[b]	$ 836,941	1.4	$ 344,020	$ 70,624	$ 150,951	13.3%	88.9%	$ 2.02[b]	$0.20[c]	3.1%	$ 7⅞-5¼[c]	—
1987[a]	859,267	87,866[d]	1,092,483	1.5	315,907	73,318	406,220	10.2	21.6	1.31[d]	0.20[c]	2.6	11-4¼[c]	—
1986	549,314	(382,197)[e,f]	1,149,950	1.1	349,854	24,499	444,901	—	—	(6.31)[e,f]	0.17	1.7	16⅛-3⅝	—
1985	1,422,995	23,933[g]	1,596,537	1.4	719,717	93,126	810,556	1.7	3.0	0.34[g]	0.20	1.7	14½-9⅛	34.7
Nalco Chemical Co.														
1988	$ 994,150	$105,971	$ 838,857	2.0	$ 311,200	$ 61,578	$ 433,550	10.7%	24.4%	$ 2.70	$1.29	3.6%	$ 39⅞-31¼	13.2
1987	841,875	80,254	696,360	1.7	304,084	57,232	396,297	9.5	20.3	2.03	1.20	3.5	45½-24	17.1
1986	736,074	63,672	536,916	1.7	280,195	63,636	358,023	8.7	17.8	1.62	1.20	4.4	31¼-23½	16.9
1985	682,333	73,332	492,998	1.8	247,912	59,905	335,685	10.7	21.8	1.87	1.20	4.8	28⅜-22	13.5
Olin Corp.														
1988	$2,308,000	$ 98,000	$1,799,000	1.3	$ 801,000	$147,000	$ 542,000	4.2%	18.1%	$ 4.63	$1.70	3.4%	$ 60-40	10.8
1987	1,930,000	78,000	1,583,000	1.7	727,000	115,000	598,000	4.0	13.0	3.38	1.60	3.6	56¼-32⅝	13.1
1986	1,707,261	75,226	1,464,830	1.5	719,686	127,935	574,290	4.4	13.1	3.36	1.525	3.5	53¼-34⅜	13.1
1985	1,751,106	(190,308)[e,h]	1,516,096	1.6	718,371	154,499	604,844	—	—	(8.28)[e,h]	1.50	4.5	38-28⅜	—
Pennwalt Corp.														
1988	$1,023,640	$ 48,256[i]	$ 917,906	1.1	$ 357,959	$ 46,694	$ 194,255	4.7%	24.8%	$ 3.87	$2.40	3.2%	$106¾-43¼	19.4
1987	1,142,750	53,803[j]	993,626	1.9	432,029	54,877	427,110	4.7	12.6	4.12[j]	2.25	4.4	68¼-34¾	12.5
1986	1,107,564	51,947	962,252	2.1	436,282	54,379	465,369	4.7	11.2	3.64	2.20	4.4	59-40¾	13.7
1985	1,013,308	11,216[k]	937,672	1.5	433,867	89,691	445,020	1.1	2.5	0.05[k]	2.20	5.6	44½-34	785.0
Quantum Chemical Corp.														
1988	$2,921,900	$360,100[l]	$2,881,300	0.7	$1,308,600	$333,500	$ (433,400)[m]	12.3%	—	$13.71	$2.40	2.8%	$108¼-65½	6.3
1987	2,566,800	143,600[n]	2,519,300	1.3	1,380,200	154,200	983,500	5.6	14.6%	4.38[n]	2.20	3.4	88-42½	14.9
1986	1,729,600	55,100[o]	2,844,200	1.0	1,393,800	101,600	944,500	3.2	5.8	1.54[o]	2.20	5.7	47⅝-30	25.3
1985	2,289,000	77,000[p]	1,948,000	.5	899,300	76,200	930,300	3.4	8.3	2.27[p]	2.20	7.2	37½-23⅝	13.5
Rohm & Haas Co.														
1988	$2,535,000	$230,000	$2,148,000	1.7	$ 935,000	$338,000	$1,113,000	9.1%	20.7%	$ 3.46	$1.02	3.1%	$ 37½-28	9.5
1987	2,203,000	195,000[q]	1,882,000	1.9	730,000	222,000	981,000	8.9	19.9	2.85[q]	0.86	2.2	53¼-24	13.6
1986	2,067,000	138,000[r]	1,756,000	2.0	648,000	179,000	916,000	6.7	15.1	2.01[r]	0.78	2.5	38¾-23⅞	15.6
1985	2,051,000	141,000[s]	1,655,000	2.0	581,000	159,000	857,000	6.9	16.5	2.01[s]	0.70	3.1	26⅛-18⅝	11.1
Sigma-Aldrich Corp.														
1988	$ 375,282	$ 56,477	$ 359,671	2.5	$ 119,518	$ 35,605	$ 243,906	15.0%	23.2%	$ 2.29	$0.33	0.7%	$ 51¼-39¾	19.9
1987	304,858	41,889	285,343	2.9	96,975	20,616	196,012	13.7	21.4	1.70	0.29	0.7	50⅝-30¼	23.8
1986	253,097	33,958	244,875	2.5	86,111	35,461	155,689	13.4	21.8	1.38	0.25	0.7	40¼-26¾	24.3
1985	214,848	28,855	186,552	3.4	57,771	17,386	126,306	13.4	22.9	1.13	0.21	0.9	28⅜-17⅛	20.1
Stepan Co.														
1988	$ 333,033	$ 13,428	$ 185,601	1.6	$ 104,697	$ 20,442	$ 66,790	4.0%	20.1%	$ 2.39	$0.475	2.1%	$ 25⅝-19¾	9.5
1987	288,935	10,959	172,726	1.6	98,994	25,705	59,936	3.8	18.3	1.83	0.415	2.0	26¾-14½	11.2
1986	259,787	7,513	152,794	1.5	85,607	14,322	55,029	2.9	13.6	1.265	0.37	2.6	17⅝-10⅜	11.3
1985	235,919	5,471	139,307	1.5	82,796	19,189	49,575	2.3	11.0	0.945	0.345	3.5	11⅜-8⅛	10.5
Union Carbide Corp.														
1988	$8,324,000	$662,000	$8,389,000	1.1	$4,416,000	$671,000	$1,784,000	8.0%	37.1%	$ 4.88	$1.15	5.1%	$ 28⅜-17	4.6
1987	6,914,000	232,000	7,820,000	1.3	4,344,000	502,000	1,175,000	3.4	19.7	1.76	1.50	6.2	32½-15½	13.6
1986	6,244,000	130,000[t]	7,496,000	1.2	4,379,000	524,000	930,000	2.1	14.0	1.25[t]	1.50	5.8	33⅛-18¾	20.8
1985[t]	6,596,000	(38,000)[u]	8,461,000	1.3	4,927,000	649,000	519,000	—	—	(0.38)[u]	1.13	6.1	24¾-12	—
Vista Chemical Corp.														
1988[v]	$ 781,351	$123,917[w]	$ 500,643	1.6	$ 275,544	$ 48,082	$ 119,438	15.9%	103.8%	$ 7.10[w]	$0.35	0.1%	$ 61-39	7.0
1987[v]	608,887	(1,762)[x,y]	474,265	1.5	266,250	20,889	134,686	—	—	(0.13)[x,y]	0.05	0.1	55⅛-18⅝	—
1986[v]	550,097	30,212[z]	453,418	1.8	272,699	15,792	60,808	5.5	49.7	1.73[z]	0.00	0.0	18¾-17	10.3
1985[v]	521,313	11,917	454,688	1.9	282,946	10,284	23,281	2.3	51.2	0.68	0.00	0.0	—	—
Witco Corp.														
1988	$1,585,856	$ 71,621[z]	$1,096,219	3.1	$ 400,996	$ 72,059	$ 559,985	4.5%	12.8%	$ 3.05[z]	$1.39	4.0%	$ 38⅜-30⅝	11.3
1987	1,427,650	63,293	1,037,624	3.0	374,628	69,082	494,941	4.4	12.8	2.72	1.16	3.1	47⅜-26⅜	13.6
1986	1,355,018	65,215	804,086	2.4	367,789	60,102	449,783	4.8	14.5	2.93	1.05	3.2	40-26⅜	11.3
1985	1,448,929	56,774	794,368	2.3	360,950	71,093	399,486	3.9	14.2	2.57	0.99	4.0	27¾-22	9.7

a Restated to reflect restructuring and spin-off of petroleum services business on Dec. 22, 1988 (except as noted). b From continuing operations; excludes net income from discontinued operations of $21.5 million ($0.32 per share) and extraordinary net gain of $7.2 million ($0.11 per share). c Before restructuring. d From continuing operations; excludes net loss from discontinued operations of $107.8 million ($1.64 per share). e Net loss. f From continuing operations; excludes net income from discontinued operations of $58.0 million ($0.51 per share). g From continuing operations; excludes net loss on disposal of discontinued operations of $2.4 million ($0.04 per share). h From continuing operations; includes special charge for restructuring costs, before taxes, of $330.0 million but excludes net income and net gain on sale of Ecusta paper and film business of $25.0 million ($1.09 per share). i From continuing operations; excludes net loss and net gain on disposal of pharmaceutical and equipment operations of $130.4 million ($10.47 per share). j From continuing operations; excludes net income from discontinued equipment operations of $1.4 million ($0.10 per share). k From continuing operations; includes special charge for restructuring program, before taxes, of $38.6 million but excludes net loss from operations and on disposal of discontinued dental businesses of $30.9 million ($2.80 per share). l From continuing operations; excludes net income from discontinued oleochemical business of $22.6 million ($0.86 per share). m Deficit. n From continuing operations; excludes net income from discontinued spirits and wine operations of $108.0 million ($3.37 per share). o From continuing operations; excludes net income from discontinued spirits and wine operations of $20.5 million ($0.67 per share). p From continuing operations; excludes net income from discontinued insurance business of $200,000 ($0.01 per share). q Includes net gain on sales of assets of $5.0 million ($0.07 per share). r Includes net loss on disposal of assets of $9.2 million ($0.13 per share). s Includes net gain on disposal of assets of $4.6 million ($0.07 per share). t From continuing operations; excludes net income and net gain on disposal of discontinued operations of $569 million ($5.49 per share) and net charges for extraordinary items of $203 million ($1.96 per share). u Pro forma; after adjustment for repurchase of common stock, sale of consumer products businesses, special charges for restructuring program, and other special gains and losses. v Fiscal year ends Sept. 30. w Includes net gain associated with change in stock option plan of $1.5 million but excludes net loss on extinguishment of debt of $10.8 million ($0.62 per share). x Includes net charge associated with change in stock option plan of $55.4 million and net gain on sale of interest in Petroquimica Argentina of $5.1 million but excludes net loss on extinguishment of debt of $1.9 million ($0.12 per share). y Excludes net loss on extinguishment of debt of $1.4 million ($0.08 per share). z Excludes net gain for cumulative effect of accounting change of $20.3 million ($0.81 per share).

Finances of the U.S. Chemical Industry

Year	Net sales	Net income	Total assets	Current ratio	Net plant and equipment	Capital expenditures	Net worth	NET INCOME % of sales	NET INCOME % of net worth	NET INCOME $ per share	Dividends, $ per share	Dividend yield, % of price	Stock price range, $ per share	Price-earnings ratio
	(Money figures in thousands of dollars unless otherwise indicated)													
Du Pont														
1988	$4,936,991	$ 752,027	$4,825,113	1.4	$1,952,622	$521,196	$2,464,649	15.2%	30.5%	$3.33	$1.20	2.5%	$ 52⅜-42⅞	14.3
1987	4,387,876	632,559	4,385,737	1.3	1,741,557	432,736	2,093,453	14.4	30.2	2.78	1.00	1.9	67-40	19.3
1986	3,807,634	540,460	3,865,609	1.3	1,543,267	383,389	1,778,921	14.2	30.4	2.32	0.84	1.9	55-31⅝	18.7
1985	3,360,273	465,335	3,468,373	1.9	1,368,542	292,900	1,870,663	13.8	24.9	1.94	0.70	2.5	36-19⅞	14.4
Exxon														
1988	$5,500,533	$ 932,184	$3,967,479	2.8	$1,309,314	$344,464	$2,332,475	16.9%	40.0%	$6.38	$3.60	4.6%	$ 84¼-71	12.2
1987	5,028,272	845,081	3,956,855	2.0	1,153,028	216,525	1,878,178	16.8	45.0	5.73	3.34	4.2	96¾-62	13.9
1986	4,926,512	778,824[a]	3,819,146	2.7	929,400	204,764	2,024,869	15.8	38.5	5.18[a]	3.10	4.0	94⅞-61¼	15.1
1985	4,684,742	717,140	3,201,746	3.3	859,414	179,347	2,098,293	15.3	34.2	4.70	2.90	5.0	66⅞-50⅛	12.4
Mobil														
1988	$5,972,500	$ 829,000	$4,988,500	2.9	$1,249,100	$252,300	$3,345,800	13.9%	24.8%	$2.88	$1.68	4.0%	$ 46½-38⅛	14.7
1987	5,401,200	709,600[b]	4,549,400	2.8	1,141,900	190,000	3,046,700	13.1	23.3	2.47[b]	1.40	3.3	55¾-28¼	17.0
1986	4,835,900	589,500	3,993,900	2.5	1,070,000	221,900	2,646,500	12.2	22.3	2.07	1.06	2.9	44¼-30⅛	18.0
1985	4,444,000	531,40[illegible]	3,557,300	2.3	925,800	222,000	2,287,100	12.0	23.2	1.93	0.905	3.1	34¼-24½	15.2
Texaco														
1988	$4,069,700	$ 761,000	$4,852,800	1.7	$1,806,600	$372,100	$2,815,400	18.7%	27.0%	$2.66	$1.15	2.8%	$ 45¾-35½	15.3
1987	3,643,800	410,500[c]	4,859,200	1.8	1,642,500	344,100	$2,646,900	11.3	15.5	1.41[c]	1.00	2.4	53⅜-28⅞	29.2
1986	3,720,400	558,200	4,117,000	1.7	1,527,600	283,000	2,260,800	15.0	24.7	2.00	0.90[c]	2.7	41¾-25¼	16.7
1985	3,270,600	517,600	3,859,400	1.7	1,374,000	207,100	2,293,400	15.8	22.6	1.84	0.80	3.6	27⅞-16⅛	11.9
Amoco														
1988	$5,939,500	$1,206,800	$5,992,100	1.7	$2,070,700	$372,700	$2,720,400	20.3%	44.4%	$3.05	$1.28	2.4%	$ 59⅝-48	17.6
1987	5,061,300	906,400	5,533,200	1.3	1,948,000	253,700	1,969,900	17.9	46.0	2.23	0.82	1.4	$ 74¼-40⅝	25.8
1986	4,128,900	675,700	4,967,900	1.7	1,906,200	210,600	2,431,800	16.4	27.8	1.62	0.63	1.9	43⅛-22⅜	20.3
1985	3,547,500	539,900	4,805,100	1.9	1,882,800	237,600	2,536,900	15.2	21.3	1.26	0.53	2.8	23-15	15.0
Phillips														
1988	$5,385,400	$ 791,300	$7,218,200	1.7	$1,655,100	$343,700	$3,881,700	14.7%	20.4%	$4.70	$2.00	3.7%	$ 60¼-47⅜	11.4
1987	4,919,800	690,200	6,684,700	2.0	1,505,900	258,300	3,644,500	14.0	18.9	4.08	1.80	3.1	77-40	14.3
1986	4,476,000	660,000	4,946,700	1.9	1,351,300	196,100	3,198,200	14.7	20.6	3.90	1.64	2.8	72⅞-46¼	15.3
1985	4,024,500	579,700	4,341,500	2.1	1,268,300	195,800	2,805,900	14.4	20.7	3.44	1.48	3.2	56¼-37⅝	13.6
Occidental														
1988	$2,969,400	$ 389,800	$3,234,500	1.2	$1,181,000	$156,100	$1,485,900	13.1%	26.2%	$3.48	$1.40	2.7%	$ 59⅜-45¼	15.0
1987	2,699,300	320,700[d]	3,053,200	1.2	1,131,100	118,000	1,317,300	11.9	24.3	2.77[d]	1.025	2.4	55¼-31¼	15.6
1986	2,398,700	265,800	2,862,000	1.3	1,143,500	124,800	1,319,700	11.1	20.1	2.17	0.90	2.5	44-28	16.6
1985	1,927,100	192,600	2,683,800	1.4	991,800	140,300	1,389,600	10.0	13.9	1.88	0.84	3.3	33¼-17⅝	13.5
Shell														
1988	$4,799,000	$ 475,700[e]	$4,033,100	1.0	$1,626,700	$298,700	$ 563,000	10.0%	84.5%	$3.83[e]	$1.84	3.7%	$ 59⅞-40⅞	13.2
1987	4,328,800	570,100	4,005,600	1.2	1,480,200	223,600	1,144,000	13.2	49.8	4.50	1.62	2.9	72¾-39¾	12.5
1986	3,745,400	521,100	3,891,400	1.3	1,410,800	236,700	965,400	13.9	54.0	3.39	1.50	3.4	52⅝-36¾	13.2
1985	3,256,600	514,400	3,534,500	1.8	1,285,300	248,000	2,070,100	15.8	24.8	3.28	1.425	4.3	39¾-26⅛	10.1
Union Carbide														
1988	$2,585,804	$ 425,456	$3,083,114	1.2	$ 938,491	$218,824	$1,400,613	16.5%	30.4%	$4.30	$1.60	2.5%	$ 70⅝-55½	14.7
1987	2,156,503	358,441	2,782,375	1.5	784,841	166,539	1,525,451	16.6	23.5	3.42	1.20	1.5	102⅞-55¼	23.1
1986	1,784,629	263,639[f]	2,408,831	1.8	645,630	95,077	1,358,096	14.8	19.4	2.45[f]	0.97	1.9	62-38⅛	20.4
1985	2,041,745	226,599	2,396,592	2.0	701,439	120,342	1,409,382	11.1	16.1	2.10	0.86	2.6	41¼-24⅞	15.7
Dow														
1988	$2,746,248	$ 353,418	$3,139,328	1.6	$1,239,598	$240,997	$1,820,952	12.9%	19.4%	$1.90	$0.80	2.6%	$ 35¼-26⅞	16.3
1987	2,521,024	305,039	3,043,131	1.9	1,114,391	211,976	1,673,512	12.1	18.2	1.63	0.63	1.6	53¾-23¼	23.6
1986	2,280,325	252,646	2,664,956	1.9	981,549	201,920	1,470,216	11.1	17.2	1.35	0.51	1.8	35½-20½	20.7
1985	2,008,486	203,193[g]	2,376,873	1.8	852,054	152,637	1,295,085	10.1	15.7	1.10[g]	0.45	2.6	23⅝-11⅛	15.8
W. R. Grace														
1988	$3,908,400	$ 340,300	$2,554,100	1.1	$1,053,000	$189,600	$ 849,900	8.7%	40.0%	$5.00	$2.16	3.1%	$ 79½-59⅞	13.9
1987	3,484,700	295,800	2,396,500	1.1	959,800	176,900	795,000	8.5	37.2	4.15	1.77	2.6	87½-48¼	16.4
1986	3,102,918	261,784[h]	2,479,054	1.4	819,291	137,996	870,453	8.4	30.1	3.54[h]	1.59	2.9	63⅛-45	15.3
1985	3,200,069	237,704[i]	2,286,187	1.2	868,931	136,774	819,279	7.4	29.0	3.05[i]	1.50	3.2	49⅝-33⅜	13.6

a Includes gain on sale of Brach confectionary business and Household Research subsidiary, before taxes, of $535 million. b Includes gain on sale of orthodontic and animal health businesses, before taxes, of $80.3 million. c From continuing operations; includes restructuring charges, before taxes, of $271.9 million but excludes net income and net gain on sale of discontinued cosmetics business of $233.2 million ($0.79 per share). d Excludes nonrecurring net charge of $4.3 million ($0.04 per share). e Excludes restructuring and other nonrecurring net charges of $389.3 million ($2.36 per share) and net gain on subsidiary sale of stock of $46.1 million ($0.37 per share). f From continuing operations; excludes net income from discontinued operations of $13.1 million ($0.12 per share), net gain on disposal of discontinued operations of $187.6 million ($1.75 per share), and extraordinary net charge for write-off of certain foreign assets of $68.0 million ($0.63 per share). g From continuing operations; excludes net loss from operations and sale of polymer chemical business of $238,000. h Excludes net nonrecurring credit from write-down and divestiture of assets and restructuring program of $47.7 million ($0.64 per share). i Excludes net nonrecurring charge for write-down and divestiture of assets and restructuring program of $553.3 million ($7.10 per share).

Chemical employment growth continues

The number of workers employed in the U.S. chemical industry rose again in 1988, reaching an annual average of 1,063,000. Even so, the 3% increase from the year before did not bring the total up to the level it was in the early 1980s, when the industry had more than 1.1 million workers. Employment in most segments of the industry increased, rising most in the drugs and cleaners sectors, but it remained steady in the paints and agricultural chemicals sectors.

With business continuing strong for chemical firms, employment is rising further this year, topping 1,080,000 this past spring.

Hiring in major individual chemical firms reversed the downtrend of 1987 and 1986. Total employment among 22 firms edged up only 0.8%, however, and still is much lower than in 1985.

Total employment of scientists and engineers in the chemical industry climbed 2% after falling in 1987 for the first time since 1976. It is now more than 50% higher than in 1978.

Employment in the chemical industry has been on the uptrend in the past two years

a Seasonally adjusted employment in U.S. chemicals and allied products industry. April and May 1989 figures are preliminary. **Source:** Department of Labor

INDUSTRIAL EMPLOYMENT

Gains in major chemical sectors last year

	All employees[a] (thousands)				Production workers[a] (thousands)				Workweek[a,b] (hours)			
	1988	1987	1986	1978	1988	1987	1986	1978	1988	1987	1986	1978
All manufacturing	19,539	19,065	18,965	20,332	13,338	12,995	12,877	14,610	41.1	41.0	40.7	40.4
Chemicals and allied products	1,063	1,026	1,022	1,088	598	576	568	624	42.3	42.3	41.9	41.9
Industrial inorganic chemicals	133	131	135	164	67	67	69	93	43.0	42.4	42.0	42.1
Plastics materials and synthetics	170	166	168	214	112	110	113	145	43.4	43.1	42.1	42.4
Drugs	229	215	208	184	103	99	96	88	41.1	41.6	41.6	41.3
Soap, cleaners, and toilet goods	163	154	147	135	105	98	93	82	40.2	41.1	41.0	40.5
Paints and allied products	62	62	63	70	31	31	37	37	41.9	41.7	41.6	41.4
Industrial organic chemicals	156	151	154	164	90	85	81	85	44.2	44.1	43.4	42.5
Agricultural chemicals	52	52	54	70	34	32	33	44	43.4	42.9	42.2	42.6
Miscellaneous chemical products	98	96	94	88	57	55	53	50	42.0	41.5	41.3	41.6
Petroleum and coal products	167	165	169	209	108	108	106	137	44.4	44.0	43.8	43.6
Rubber and miscellaneous plastics products	873	823	790	749	679	639	615	587	41.6	41.6	41.3	40.8

a Domestic employment. b Workweek of production or nonsupervisory workers. **Source:** Department of Labor

EMPLOYMENT OF SCIENTISTS, ENGINEERS

Down for second year for industrial chemicals

Thousands[a]	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978
Total, all industry	725.8	703.8	676.5	626.2	586.5	541.9	509.8	487.8	450.6	423.9	404.4
Chemicals and allied products	74.9	73.0	75.8	71.1	69.8	67.3	61.6	54.7	51.4	50.0	48.3
Industrial chemicals	23.2[b]	24.4	24.9	23.5	25.6	26.6	25.9	21.6	20.9	21.4	21.3
Drugs and medicines	31.2	29.2	31.8	30.8	30.8[b]	28.2	25.6	23.3	21.6	20.8	19.5
Other chemicals	20.5	19.4	19.1	16.7	13.4	12.1	10.1	9.8	8.9	7.8	7.5
Petroleum refining	9.5	8.6	10.4	13.5	13.3	14.7	15.6	13.0	10.8	10.1	9.9
Rubber products	na	12.5	13.0	13.0	na	na	8.1	10.3	na	8.1	7.9

a Full-time equivalent number of R&D scientists and engineers in industry, as of January of each year. b Partly estimated. na = not available separately, but included in total. **Source:** National Science Foundation

CHEMICAL EMPLOYMENT: Up slightly last year but still far below pre-1986 levels

Thousands	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978
Air Products	13.3	12.1	16.6	18.7	17.7	16.7	18.9	16.2	15.8	14.6	14.3
American Cyanamid	35.5	34.3	34.5	36.4	38.2	38.7	40.2	41.8	42.6	44.2	44.0
Betz Laboratories	3.1	2.0	2.6	2.5	2.5	2.3	2.2	2.2	2.1	2.0	1.8
Cabot Corp.	5.2	5.1	6.6	7.7	7.5	7.2	7.5	7.7	7.6	8.1	7.9
Chemed	5.6	4.8	4.8	4.3	4.3	4.1	3.5	3.6	3.6	3.3	3.1
Crompton & Knowles	1.6	1.3	1.3	2.3	2.3	2.4	2.3	2.5	2.8	3.0	3.2
Dow Chemical	55.5	53.1	51.3	53.2	49.8	54.5	56.6	63.8	56.8	55.9	53.5
Ethyl	10.4	10.0	10.5	10.5	11.0	13.0	14.0	14.5	15.0	16.0	16.5
H. B. Fuller	5.2	4.6	4.5	4.4	4.3	4.1	4.0	3.3	3.4	3.4	3.3
W. R. Grace	45.7	39.4	41.4	116.9	102.6	95.5	82.2	89.0	92.0	82.8	69.1
Hercules	22.7	23.2	25.1	25.4	26.3	24.2	24.5	25.9	26.1	27.4	27.1
International Flavors	4.2	4.1	3.8	3.7	3.7	3.7	3.6	3.6	3.6	3.6	3.5
International Minerals	6.9	12.9	13.9	8.7	9.0	8.4	8.4	10.6	10.6	10.3	9.9
Lubrizol	4.8	4.8	4.8	5.2	4.2	4.2	4.3	4.2	4.2	3.9	3.8
Monsanto	45.6	49.7	51.7	56.1	50.8	48.8	52.2	57.4	61.8	63.9	62.9
Nalco Chemical	5.4	5.1	4.9	5.1	4.8	4.6	4.6	4.7	4.3	4.1	4.1
Olin	16.4	14.1	13.2	14.9	17.8	18.2	17.5	20.3	21.0	21.7	22.7
PPG Industries	36.3	36.8	36.5	37.5	37.7	37.0	37.0	36.6	37.3	38.2	37.4
Pennwalt	5.0	9.0	9.6	9.9	9.8	9.8	9.5	10.7	12.8	13.3	14.0
Rohm & Haas	12.4	12.0	12.1	11.8	11.9	11.4	11.5	13.5	13.2	13.3	13.1
Stepan	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.8
Union Carbide	44.0	43.1	50.3	91.5	98.4	99.5	103.2	110.3	116.1	115.8	113.4
TOTAL EMPLOYEES	**385.8**	**382.6**	**400.9**	**527.6**	**515.5**	**509.1**	**508.6**	**543.3**	**553.4**	**549.7**	**529.5**
ANNUAL CHANGE	**0.8%**	**−4.6%**	**−24.0%**	**2.4%**	**1.2%**	**0.1%**	**−6.4%**	**−1.8%**	**0.7%**	**3.8%**	**1.6%**
SALES PER EMPLOYEE ($ thousands, current)	**$179.6**	**$159.9**	**$135.3**	**$114.4**	**$115.5**	**$110.0**	**$107.7**	**$109.3**	**$101.8**	**$ 92.6**	**$ 79.7**
SALES PER EMPLOYEE ($ thousands, constant 1982[a])	**$154.3**	**$150.3**	**$132.0**	**$110.3**	**$112.3**	**$109.8**	**$107.7**	**$111.0**	**$114.3**	**$121.6**	**$117.1**

Note: Data are not restated for acquisitions, divestitures, or similar developments. a Based on producer price index for chemicals and allied products

WAGES: Trend heads steadily upward in the chemical industry

	Hourly earnings[a]				Weekly earnings[a]			
	1988	1987	1986	1978	1988	1987	1986	1978
All manufacturing	$10.17	$ 9.91	$ 9.73	$6.17	$417.99	$406.31	$396.01	$249.27
Chemicals and allied products	12.67	12.37	11.98	7.01	535.94	523.25	501.96	293.72
Industrial inorganic chemicals	13.87	13.56	13.11	7.62	596.41	574.94	550.62	320.80
Plastics materials and synthetics	13.01	12.59	12.13	6.87	564.63	542.63	510.67	291.29
Drugs	12.05	11.62	11.16	6.42	495.26	483.39	464.26	265.15
Soap, cleaners, and toilet goods	11.05	10.90	10.76	6.66	444.21	447.99	441.16	269.73
Paints and allied products	11.24	10.84	10.44	6.32	470.96	452.03	434.30	261.65
Industrial organic chemicals	15.06	14.90	14.39	8.23	665.65	657.09	624.53	349.78
Agricultural chemicals	12.29	11.91	11.44	6.69	533.39	510.94	482.77	284.99
Miscellaneous chemical products	11.53	11.36	11.07	6.54	484.26	471.44	457.19	272.06
Petroleum and coal products	15.05	14.59	14.19	8.60	668.22	641.96	621.52	374.96
Rubber and miscellaneous plastics products	9.11	8.91	8.73	5.50	378.98	370.66	360.55	224.40

a For production and nonsupervisory workers in domestic employment. Source: Department of Labor

CIRCLE 60 ON READER SERVICE CARD

3 Employment in the Chemical Industry

With increases in production last year, productivity of workers in the U.S. chemical industry rose for the sixth straight year. And 1988's productivity increase soundly beat the increase that occurred in 1987. Meanwhile, unit labor costs for chemical production dropped once more after a very slight rise in the previous year. For both measures the chemical industry beat out performance for all manufacturing.

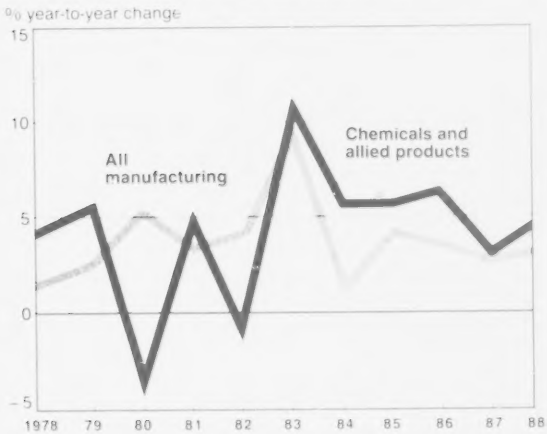
Based on government figures, C&EN calculates that productivity in the chemical industry increased 4.4% in 1988, compared with a 3.1% gain the year before. But last year's improvement was still below increases chalked up during the years immediately following the recession in the early 1980s. The productivity last year resulted from an 8.4% increase in production but only a 3.8% increase in hours worked in the chemical industry. Since 1982, production in the chemical industry has increased nearly 50%. But as a result of tightened efficiency and cutbacks in employment by the industry during the mid-1980s, workhours have remained practically unchanged. Consequently, productivity also has been lifted by more than 40%.

Meanwhile, unit labor costs, the measure of how much it costs in worker wages to produce a product, fell once again after a slight rise in 1987. The 1.9% decline last year is the fifth decrease in the past six years. In 1987, unit labor costs for chemicals and allied products were essentially flat, rising just 0.3% from the year before.

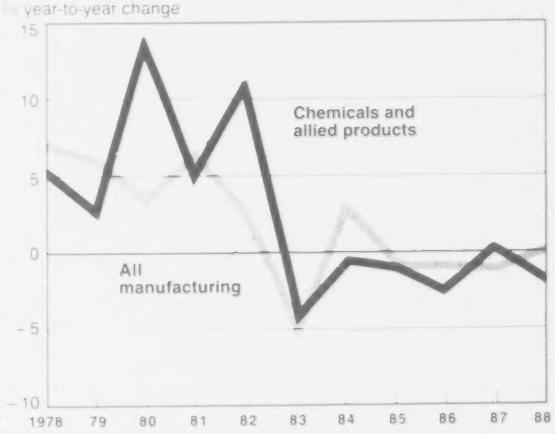
The chemical industry continued to outperform all manufacturing last year. Productivity for all manufacturing rose 3.0%, well below chemicals' 4.4%. And unit labor costs for all manufacturing were unchanged from the year before. In 1987, productivity for all manufacturing was up 2.7% and unit labor costs fell 1.0%.

One reason why productivity increased less for all manufacturing than in the chemical industry is that production in all manufacturing increased just 6% last year.

Productivity improves for chemicals . . .



. . . pushing unit labor costs down further



Note: Productivity is output per workhour, calculated by dividing indexes for production by indexes for workhours of production employees. Unit labor costs are labor costs per unit of output, calculated by dividing indexes for wages by indexes for output per workhour. Sources: Federal Reserve Board, Department of Labor, C&EN estimates

PRODUCTIVITY **Strong growth in output spurs further improvement**

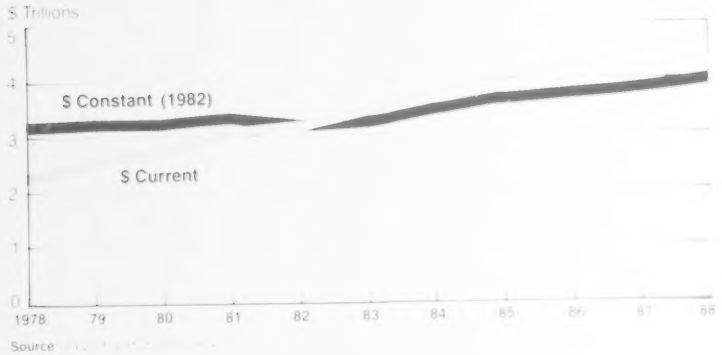
Indexes, 1977 = 100	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978
CHEMICALS AND ALLIED PRODUCTS											
Production	151.9	140.2	133.0	127.1	121.6	113.9	103.8	112.6	106.4	113.3	106.3
Workhours	98.3	94.7	92.6	94.1	95.0	93.9	95.2	101.7	101.0	103.1	102.2
Productivity	154.5	148.0	143.6	135.1	128.0	121.3	109.0	110.7	105.3	109.9	104.0
Hourly production wages	197.0	192.4	186.1	180.1	172.7	164.8	155.0	141.8	129.2	118.2	109.2
Unit labor costs	127.5	130.0	129.6	133.3	134.9	135.9	142.2	128.1	122.6	107.6	105.0
ALL MANUFACTURING											
Production	142.7	134.7	129.2	126.4	123.4	113.9	102.2	110.5	108.2	110.7	106.1
Workhours	96.1	93.4	92.0	93.1	94.8	88.2	87.0	97.9	98.9	106.4	104.5
Productivity	148.5	144.2	140.4	135.8	130.2	129.1	117.5	112.9	109.4	104.0	101.5
Hourly production wages	179.1	174.0	171.1	166.9	161.5	155.4	149.6	140.7	128.1	118.0	108.6
Unit labor costs	120.6	120.7	121.8	122.9	124.1	120.3	127.4	124.7	117.1	113.4	107.0

Sources: Federal Reserve Board, Department of Labor, C&EN estimates

← CIRCLE 60 ON READER SERVICE CARD

Markets for the U.S. Chemical Industry

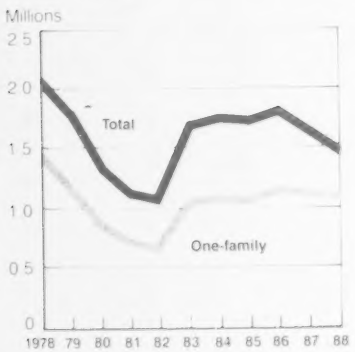
Gross national product



Source:

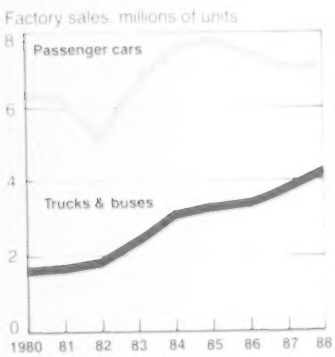
For the sixth year in a row, the willingness of U.S. consumers to keep their purse strings open has propelled the U.S. economy forward. Spending for personal consumption was up 7% in 1988—or nearly 3% if allowance is made for inflation. That's a rate of growth that has changed little in the past two or three years and is still strong enough to keep the overall economy in an expansionary mode. And because the chemical industry's diverse array of products more often than not eventually find their way directly or indirectly into consumer products, chemical producers have benefited greatly from the uptrend.

Housing starts



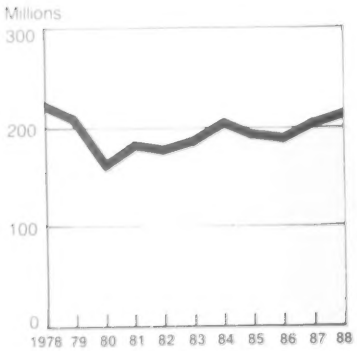
Source: Bureau of the Census

Motor vehicles



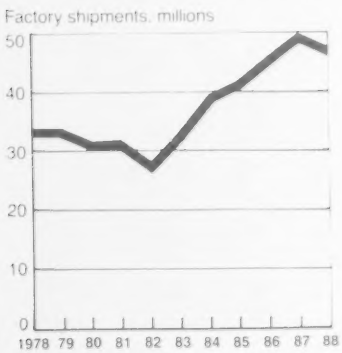
Source: Motor Vehicle Manufacturers Association

Tires and tubes



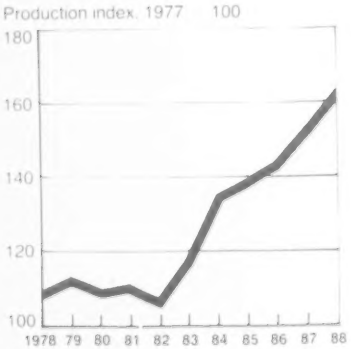
Source: Rubber Manufacturers Association

Major home electrical appliances



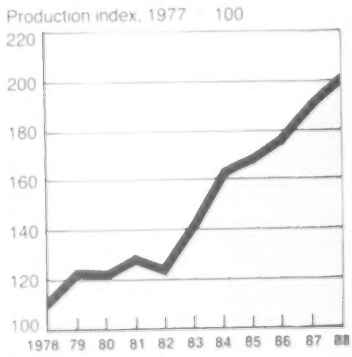
Source: Association for Home Appliance Manufacturers

Furniture and fixtures



Source: Federal Reserve Board

Miscellaneous plastics products

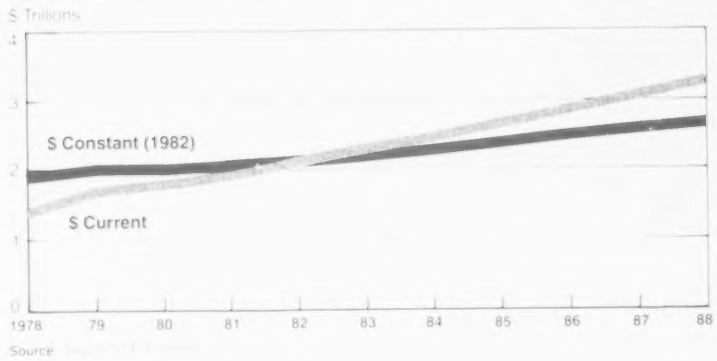


Source: Federal Reserve Board

Not all of the industry's markets have been equally firm recently, to be sure. New housing, one of the most important, has been weakening since 1986, and new housing starts are expected to dwindle a bit further again this year. Although auto assemblies are up nearly 5% so far in 1989, slower sales may well lead to lower car output in the U.S. for the year as a whole. Other markets, too, have started to show some hints of slackening.

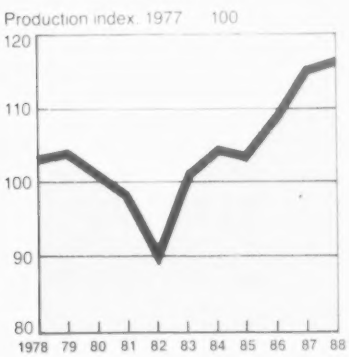
For 1989, therefore, markets for chemicals overall may noticeably soften, in line with the U.S. economy in general. Nevertheless, most industry observers remain convinced that, as long as consumers remain in a spending mood, this year will see new records set in demand for chemical products as a group.

Personal consumption expenditures



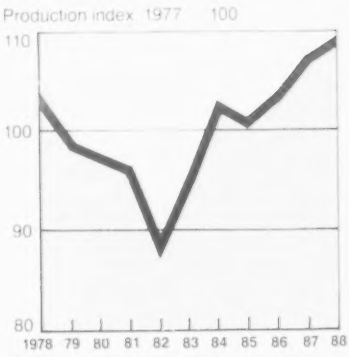
Source:

Textile mill products



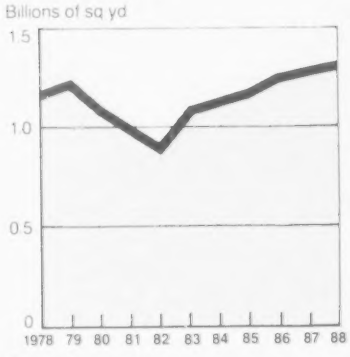
Source: Federal Reserve Board

Apparel



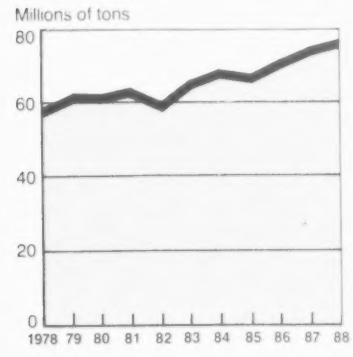
Source: Federal Reserve Board

Floor coverings



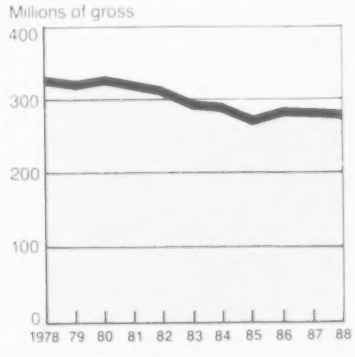
Source: Bureau of the Census

Paper and paperboard



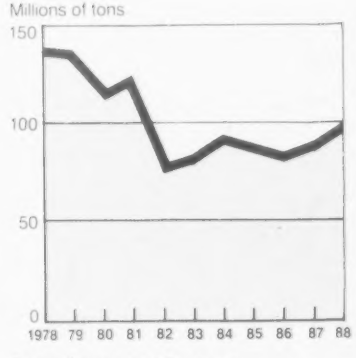
Source: American Paper Institute

Glass containers



Source: Bureau of the Census

Steel



Source: American Iron & Steel Institute

U.S. chemical trade surplus sets a new high

Growth in economic activity was robust throughout the industrialized world last year. One result was that world trade in chemicals, measured in U.S. dollars, rose a healthy 14% to almost a quarter of a trillion dollars.

And aided by the continued depressed level of the U.S. dollar vis-à-vis currencies of most of the rest of the industrialized countries, U.S. chemical makers managed to garner a slightly larger share of the total global market after having experienced a three-year decline in their market share. U.S. exports, all in all, swelled 22% to a record $32 billion, the biggest one-year advance since 1979. Sales were particularly strong to China and other Asian developing countries. Best showing among major product areas was tallied by plastics, with foreign customers upping their purchases by about a third.

But trade is a two-way street. And with the U.S. economy still buoyant, U.S. capacity strained for many chemical products, and several foreign competitors expanding their output, imports of chemicals increased at about the same clip, also hitting a new peak of just under $20 billion. Latin American producers boosted their sales to the U.S. about 40%.

Even so, the U.S. balance of trade in chemicals expanded for the third year in a row to $12.4 million, edging just above its previous all-time high set in 1980. Although the U.S. dollar has strengthened a bit this year, it is still markedly weaker relative to other major world currencies than it was before 1987. And the largest markets still seem healthy. U.S. chemical companies, therefore, are looking for further gains in their overseas sales and the nation's chemical trade surplus is likely to widen again this year.

Deficit narrows moderately

$ Billions	1988	1987	1986	1978
Total exports	$ 322.2	$ 254.1	$ 227.2	$ 143.8
Total imports	440.9	406.2	365.4	172.0
Trade balance	−118.7	−152.1	−138.2	−28.2

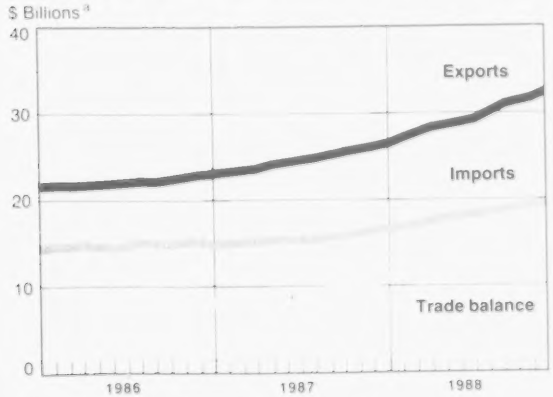
Source: Department of Commerce

Surplus continues to widen

$ Millions	1988	1987	1986	1978
Chemical exports	$32,300	$26,381	$22,766	$12,618
Chemical imports	19,876	16,213	15,001	6,427
Chemical trade balance	12,424	10,168	7,765	6,191

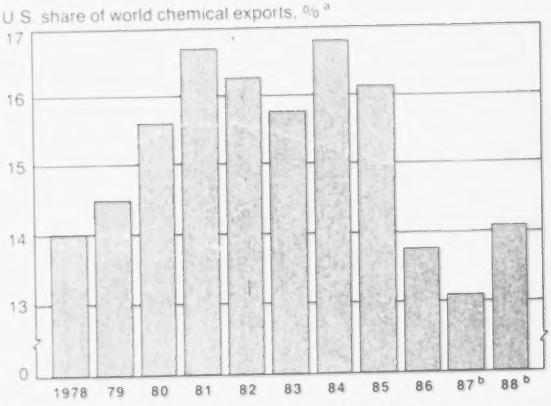
Source: Department of Commerce

Strong growth for U.S. chemical exports . . .



a Running 12-month totals. Source: Department of Commerce

. . . brings upturn in share of world market



a U.S. chemical exports as a percentage of total world chemical exports less chemical imports. b C&EN estimates

U.S. TRADE: Growth continues worldwide

$ Millions	1988	1987	1986	1978
U.S. CHEMICAL EXPORTS				
Canada	$ 3,800	$ 3,277	$ 2,668	$ 1,739
Latin America	5,145	4,407	4,025	2,679
Western Europe	9,276	7,987	7,032	4,275
Eastern Europe	341	344	385	62
Communist Asia	1,388	808	441	61
Japan	4,002	3,422	3,081	1,104
Middle East	549	423	345	367
Rest of Asia	5,781	4,121	3,377	1,324
Australasia	1,080	834	689	417
Africa	600	500	447	349
Other	338	258	276	241
TOTAL	**$32,300**	**$26,381**	**$22,766**	**$12,618**
U.S. CHEMICAL IMPORTS				
Canada	$ 3,782	$ 3,052	$ 2,752	$ 1,805
Latin America	1,324	942	942	312
Western Europe	10,212	8,220	7,357	3,227
Eastern Europe	219	165	327	78
Communist Asia	234	200	179	34
Japan	2,187	2,150	1,792	563
Middle East	298	238	238	41
Rest of Asia	824	698	623	124
Australasia	322	235	221	115
Africa	103	74	326	46
Other	371	239	244	82
TOTAL	**$19,876**	**$16,213**	**$15,001**	**$ 6,427**

Source: Department of Commerce

WORLD TRADE: Strong uptrend is maintained

$ Millions	1988	1987	1986	1978
CHEMICAL EXPORTS				
World	$249,000[a]	$218,000[a]	$180,500[a]	$95,927
U.S.	32,300	26,381	22,766	12,618
Canada	6,266	4,639	3,968	2,111
EC, 12 countries	135,000[a]	119,600	97,961	55,205
Belgium-Luxembourg	13,050[a]	10,444	8,597	5,701
France	23,449	20,439	16,763	8,835
Italy	9,767	8,745	7,060	3,710
Netherlands	17,850[a]	16,740	13,786	7,425
U.K.	17,012	17,285	14,205	8,064
West Germany	43,819	38,172	31,202	18,835
Switzerland	11,800	9,976	8,124	4,804
Japan	13,964	11,662	9,484	5,102
CHEMICAL IMPORTS				
U.S.	$ 19,876	$16,213	$15,001	$ 6,427
Canada	5,825	4,708	4,199	2,556
EC, 12 countries	112,600[a]	95,898	78,167	40,095
Belgium-Luxembourg	11,400[a]	8,698	7,119	4,627
France	19,545	16,892	13,708	7,280
Italy	16,049	13,689	11,001	4,725
Netherlands	11,650[a]	9,653	7,889	4,175
U.K.	15,290	13,680	10,772	5,293
West Germany	24,299	21,454	17,686	8,785
Switzerland	7,600	5,721	4,796	2,421
Japan	14,830	11,845	9,733	3,763

a C&EN estimates. **Sources:** United Nations, Organization for Economic Cooperation & Development, European Community, individual government agencies

U.S. TRADE, BY PRODUCTS: Organic chemicals and plastics account for about half

	Chemical exports				Chemical imports			
$ Millions	1988	1987	1986	1978	1988	1987	1986	1978
Organic chemicals	$ 9,381	$ 7,550	$ 6,293	$ 3,369	$ 6,953	$ 5,408	$ 4,704	$1734
Plastics and resins	7,277	5,492	4,301	2,088	2,433	1,987	1,837	518
Medicinals and pharmaceuticals	3,941	3,182	3,090	1,404	1,859	1,456	1,240	449
Inorganic chemicals	2,702	2,112	1,771	1,207	2,498	2,030	1,894	915
Fertilizers, manufactured	2,498	2,259	1,935	1,091	1,021	795	865	869
Pesticides and disinfectants	910	732	664	445	577	398	580	159
Radioactive materials	868	1,017	1,302	717	1,098	1,012	1,382	912
Flavors, perfumes, cosmetics, and toiletries	709	579	488	356	932	796	679	230
Pigments, paints, and varnishes	449	411	333	241	395	427	348	63
Cleaning and polishing materials	395	357	302	250	260	205	214	62
Dyeing, tanning, and coloring materials	258	217	174	145	610	621	487	171
Explosives and pyrotechnics	91	91	81	65	118	110	111	43
Miscellaneous	2,821	2,382	2,032	1,240	1,122	968	660	303
TOTAL	**$32,300**	**$26,381**	**$22,766**	**$12,618**	**$19,876**	**$16,213**	**$15,001**	**$6427**

Source: Department of Commerce

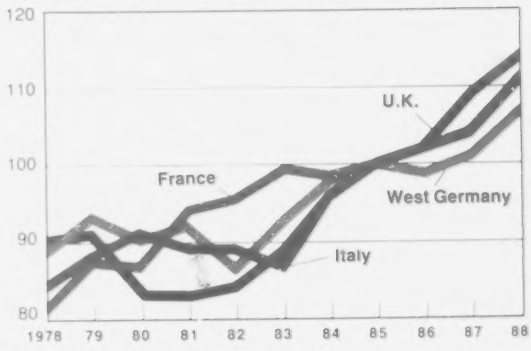
6 Foreign Chemical Industries — Western Europe

West Germany's three largest chemical companies—Bayer, BASF, and Hoechst—again were the leaders in chemical sales in Western Europe last year, although not quite in the same order as in previous years. And the U.K.'s ICI followed as a close fourth behind them. A significant gap remained between these four and the next tier, led by Ciba-Geigy of Switzerland and France's Rhône-Poulenc.

For chemical companies large or small, however, 1988 generally was a year of increased output and expansion, coupled with improved profit margins. Although production of a number of products declined in Italy and West Germany, solid gains in chemical output were widespread, particularly for such big-volume polymers as polyethylene, polypropylene, and polyvinyl chloride. Fiber production, for the most part, increased or at least held steady, an improvement from several years of losses.

Chemical output up sharply in recent years

Production index, 1985 = 100



Source: European Chemical Industry Federation (CEFIC)

CHEMICAL INDUSTRY TRENDS: 1988 was upbeat year for sales, production, and prices

$ Billions (U.S.)	1988	1987	1986	1985	1984
WEST GERMANY					
Sales	$ 85.7	$ 78.0	$ 64.5	$ 50.5	$ 49.5
Exports	45.4	40.2	33.2	26.1	25.1
Imports	25.6	22.6	18.8	15.0	14.0
Capital spending	6.0	5.3	3.5	2.4	2.2
Production index[a]	106.5	101.1	99.1	100.0	97.9
Price index[a]	92.4	91.1	94.2	100.0	97.1
Employees (thousands)	575	572	567	557	550
FRANCE[b]					
Sales	$ 53.3	$ 47.4	$ 40.7	$ 31.8	$ 30.9
Exports	21.9	19.0	15.7	12.8	12.2
Imports	18.2	15.4	12.5	10.0	9.2
Capital spending	2.9	2.5	1.9	1.3	1.1
Production index[a]	111.2	104.1	101.0	100.0	98.3
Price index[a]	100.2	96.3	97.5	100.0	102.2
Employees (thousands)	266	268	268	272	279
U.K.[b]					
Sales	$ 44.5	$ 36.9	$ 30.6	$ 26.3	$ 25.2
Exports	20.1	17.3	14.3	12.1	11.0
Imports	16.6	13.7	11.0	9.0	8.8
Capital spending	3.0	2.3	1.9	1.6	1.4
Production index[a]	114.3	109.0	101.1	100.0	95.4
Price index[a]	111.6	105.8	101.4	100.0	95.1
Employees (thousands)	346	336	336	336	329
ITALY					
Sales	$ 42.8	$ 37.5	$ 30.7	$ 24.5	$ 23.6
Exports	10.9	9.3	7.8	6.6	6.2
Imports	17.1	14.7	12.0	9.3	8.6
Capital spending	2.1	1.8	1.3	0.9	0.9
Production index[a]	110.5	103.6	101.4	100.0	96.3
Price index[a]	107.5	100.4	97.3	100.0	92.8
Employees (thousands)	223	225	230	233	241
SPAIN[b]					
Sales	$ 30.4	$ 25.8	$ 20.7	$ 16.1	$ 15.2
Exports	5.0	4.2	3.1	2.9	2.7
Imports	7.5	6.3	4.7	3.1	3.0
Capital spending	0.6	0.5	0.4	0.3	0.2
Production index[a]	122.5	112.4	105.0	100.0	97.4
Price index[a]	104.6	102.5	101.0	100.0	93.0
Employees (thousands)	239	239	239	240	241
BELGIUM[c]					
Sales	$ 22.7	$ 19.8	$ 17.2	$ 14.1	$ 13.6
Exports[d]	16.4	14.7	12.2	9.6	9.1
Imports[d]	13.5	10.7	8.6	6.9	6.6
Capital spending	1.5	1.0	0.7	0.4	0.4
Production index[a]	120.0	110.6	102.6	100.0	96.8
Price index[a]	97.0	94.0	97.7	100.0	96.5
Employees (thousands)	92	91	91	90	89
NETHERLANDS					
Sales	$ 22.3	$ 19.5	$ 16.0	$ 13.9	$ 13.6
Exports	21.8	19.0	15.7	12.9	12.5
Imports	12.6	11.5	9.5	8.0	7.2
Capital spending	1.8	1.5	1.2	0.8	0.8
Production index[a]	108.5	104.0	100.0	100.0	91.7
Price index[a]	88.5	87.0	85.4	100.0	94.3
Employees (thousands)	92	91	91	89	89
SWITZERLAND[c]					
Sales	$ 12.8	$ 11.5	$ 9.3	$ 6.7	$ 6.5
Exports	10.9	9.8	7.9	5.7	5.4
Imports	6.4	5.6	4.7	3.6	3.4
Production index[a]	120.0	105.3	102.1	100.0	94.1
Price index[a]	91.9	90.8	97.3	100.0	95.9
Employees (thousands)	70	69	68	66	65
SWEDEN					
Sales	$ 7.6	$ 6.3	$ 5.0	$ 4.1	$ 4.1
Exports	3.6	3.0	2.5	1.9	1.8
Imports	4.6	3.9	3.2	2.7	2.5
Capital spending	0.5	0.5	0.4	0.3	0.3
Production index[a]	na	106.3	99.3	100.0	100.5
Price index[a]	na	103.2	101.6	100.0	94.5
Employees (thousands)	46	45	42	43	44
FINLAND					
Sales	$ 3.9	$ 3.6	$ 3.1	$ 2.4	$ 2.4
Exports	0.6	0.6	1.2	1.0	1.0
Imports	1.0	1.1	2.1	1.6	1.5
Capital spending	1.1	0.5	0.4	0.3	0.3
Production index[a]	98.5	92.1	102.1	100.0	96.0
Price index[a]	99.7	94.5	96.3	100.0	na
Employees (thousands)	24	24	24	25	25
NORWAY					
Sales	$ 3.2	$ 2.9	$ 2.3	$ 2.0	$ 2.1
Exports	1.9	1.6	1.3	1.2	1.2
Imports	1.9	1.6	1.4	1.1	1.0
Capital spending	0.2	0.2	0.2	0.1	0.1
Production index[a]	103.0	103.0	100.0	100.0	96.0
Price index[a]	na	106.0	101.5	100.0	100.9
Employees (thousands)	15	15	15	15	16

a 1985 = 100. b Excludes fibers. c Includes rubber and plastics processing. d Includes Luxembourg for exports and imports. na = not available. **Sources:** National agencies and European Chemical Industry Federation (CEFIC)

MAN-MADE FIBERS: Generally little or no growth in output for major producing countries

Millions of lb	1988		1987		1986		1985		1984		Change, 1987–88	
	Non-cellulosics	Cellulosics	Non-cellulosics	Cellulosics	Non-cellulosics	Cellulosics	Non-cellulosics	Cellulosics	Non-cellulosics	Cellulosics	Non-cellulosics	Cellulosics
West Germany	1817	376	1806	356	1738	354	1764	372	1674	359	1%	6%
Italy	1452	55	1441	64	1430	66	1409	67	1329	68	1	14
Turkey	620	20	572	18	504	18	409	18	356	11	8	11
Spain	590	81	591	78	601	80	633	80	599	73	0	4
U.K.	515[a]	238[b]	513[a]	208[b]	524[a]	207[b]	557[a]	247[b]	561[a]	372[b]	0	14
France	392	33	382	50	392	45	427	44	456	61	3	−34
Benelux countries	385	119	399	109	379	108	365	95	318	94	−4	9
Switzerland	242	0	227	0	216	0	226	0	218	0	7	—
Ireland	176	0	172	0	162	0	140	0	136	0	2	—
Portugal	128	2	139	2	136	2	134	1	119	1	−8	0
Austria	70	290	68	264	61	271	63	265	59	267	3	10
Finland	7	132	4	118	3	121	3	134	3	143	75	12

a Includes cellulose acetate filament. b Excludes cellulose acetate filament. **Source:** Comité International de la Rayonne et des Fibres Synthétiques

PRODUCTION: Biggest increases last year were in petrochemicals and plastics

Millions of lb	1988	1987	1986	1985	Change 1987–88
FRANCE					
Sulfuric acid	8846	8618	8826	9433	3%
Hydrochloric acid	1507	1427	1381	1446	6
Chlorine	3121	2971	3151	3060	6
Sodium hydroxide	3258	3123	3304	3196	4
Ammonia	4031	4466	4455	4422	−10
Benzene	1544	1439	1332	1399	7
Toluene	104	72	83	89	44
Xylenes	493	284	250	277	74
Ethylene	5361	5319	4980	4749	1
Propylene	3298	3073	2283	2730	7
Butadiene	737	677	641	634	9
Formaldehyde	193	180	176	203	7
Polyethylene	2620	2523	2471	2266	4
Polypropylene	1278	1159	1034	933	10
Polystyrene	1177	1166	1089	1074	1
Polyvinyl chloride	2237	2039	1960	1804	10
Synthetic rubber	1251	1184	1193	1199	6
Phosphate fertilizers[a]	700	1209	1267	1340	−42
ITALY					
Sulfuric acid	9714[b]	9589	9170	9588	1%
Nitric acid	2580[b]	2422	2402	2599	7
Phosphoric acid	813[b]	842	830	886	−3
Chlorine	2351[b]	2294	2106	2031	2
Sodium hydroxide	2609[b]	2676	2294	2268	−3
Sodium perborate	235[b]	245	212	218	−4
Ammonia	3793[b]	3839	4155	3250	−1
Benzene	1369[b]	1311	1107	1075	4
Toluene	503[b]	402	512	766	25
Xylenes	965[b]	1067	893	952	−10
Formaldehyde	279[b]	297	297	301	−6
Acetic acid	145[b]	140	116	129	4
Carbon black	436[b]	420	418	403	4
Polyethylene	1840[b]	1691	1504	1408	9
Polystyrene	639[b]	664	785	707	−4
Polyvinyl chloride	1718[b]	1380	1408	135	24
Nitrogen fertilizers[c]	7166[b]	6999	6948	7217	2

a As P_2O_5. b C&EN estimates. c As N. d Manufacturers' sales. e From petroleum refining only. f Excludes calcium cyanamid fertilizers. na = not available. **Sources:** Government agencies for each country

Millions of lb	1988	1987	1986	1985	Change 1987–88
U.K.					
Sulfuric acid	4967	4797	5125	5621	4%
Hydrochloric acid[d]	388	384	346	337	1
Chlorine	na	2256	2143	2269	—
Benzene	2072	2005	1876	1863	3
Ethylene	4464	3955	3828	3182	13
Propylene	2985	1929	1901	2141	55
Butadiene	527	509	424	655	4
Titanium dioxide	586	562	506	482	4
Acetone	280	259	271	323	8
Formaldehyde	246	250	227	272	−2
Polyethylene	1015	876	940	1144	16
Polypropylene	692	611	652	592	13
Polyvinyl chloride	353	390	400	391	−9
Synthetic rubber	688	565	636	593	22
WEST GERMANY					
Sulfuric acid	7186	7260	7344	7571	−1%
Hydrochloric acid	2160	2179	2048	2079	−1
Nitric acid	5098	5818	6210	6361	−12
Chlorine	7701	7595	7538	7686	1
Sodium hydroxide	7602	7523	7485	7581	1
Sodium carbonate	3089	3195	3173	3096	−3
Sodium sulfate	385	361	359	306	7
Carbon black	836	796	844	852	−2
Ammonia	4816	5098	4146	5036	−6
Benzene	3536	3316	3373	2723[e]	7
Toluene	1013	884	1052	860	15
Xylenes	1296	1102	1190	1089	18
Aniline	386	309	408	369	25
Ethylene	6889	6118	5868	6661	13
Propylene	3396	3467	3093	3665	−2
Butadiene	1677	1543	1505	1851	9
Ethylene oxide	1381	1223	1098	1073	13
Ethylene glycol	521	536	500	504	−3
Propylene oxide	1209	1181	1174	1179	2
Propylene glycol	427	379	395	371	13
n-Butanol	685	689	689	604	−1
Acetaldehyde	789	727	686	726	9
Acetic acid	754	704	653	655	7
Ethanol	228	240	217	170	−5
Formaldehyde	1505	1341	1265	1253	12
Phthalic anhydride	612	522	433	378	17
Polyethylene	3235	2980	2785	2725	9
Polyvinyl chloride	3105	2904	2732	2658	7
Synthetic rubber	1101	1035	1026	1007	6
Nitrogen fertilizers[f]	na	1674	1684	1826	—

COMPANY RESULTS: With profitability up throughout Europe, plant and R&D outlays rise

$ Millions	Net sales	Net income	Profit margin	Capital spending	R&D spending	Employees (thousands)
BASF (West Germany)						
1988	$24,925.0	$ 813.8	3.3%	$1985.8	$1016.5	134.8
1987	22,354.4	586.1	2.6	1532.2	896.1	133.8
1986	18,650.2	419.4	2.2	1224.4	676.5	131.5
1985	15,094.2	339.5	2.2	950.3	488.1	130.2
Hoechst (West Germany)						
1988	$23,275.0	$1144.9	4.9%	$1579.5	$1372.7	164.5
1987	20,531.1	848.9	4.1	1330.0	1231.7	167.8
1986	17,518.0	644.7	3.7	1234.6	985.3	181.2
1985	14,531.3	499.3	3.4	804.4	708.5	180.6
Bayer (West Germany)						
1988	$22,993.2	$1090.3	4.7%	$1786.9	$1397.7	165.7
1987	20,635.0	857.8	4.2	1425.0	1301.7	164.4
1986	18,778.3	687.1	3.7	1093.5	955.8	173.0
1985	15,621.1	488.4	3.1	700.0	725.9	176.1
ICI (U.K.)						
1988	$20,816.7	$1567.6[a]	7.5%	$1443.1	$1005.3	130.4
1987	18,234.4	1245.9	6.8	1160.7	755.7	127.8
1986	14,862.2	879.8[b]	5.9	942.8	573.3	121.8
1985	13,892.5	715.0[c]	5.1	821.2	452.1	118.6
Ciba-Geigy (Switzerland)						
1988	$12,087.0	$ 907.5	7.5%	$1106.8	$1230.8	88.8
1987	10,579.9	738.3	7.0	918.1	1122.8	86.1
1986	8,863.9	645.0	7.3	684.4	903.9	82.2
1985	7,406.9	598.4	8.1	493.1	680.5	81.0
Rhone-Poulenc (France)						
1988	$10,962.1	$ 580.0	5.3%	$ 990.1	$ 641.4	79.7
1987	9,344.3	392.7	4.2	830.4	585.4	83.0
1986	7,603.8	289.8	3.8	732.5	426.3	78.0
1985	6,240.5	257.1	4.1	460.5	317.6	78.0
Montedison (Italy)						
1988	$10,846.4	$ 483.9[d]	4.4%	$ 823.3	$ 389.6	47.1
1987	10,641.2	436.7	4.1	786.3	290.9	47.9
1986	8,607.6	(46.1)[e,f]	—	570.8	207.9	66.6
1985	7,402.8	126.3[g]	1.7	342.6	157.2	69.7
Norsk Hydro (Norway)						
1988	$ 9,206.7	$ 526.7[h]	5.7%	$1355.2	$ 113.5	39.5
1987	8,086.5	311.0[h]	3.8	1451.0	97.2	39.1
1986	7,341.0	(41.4)[e,h]	—	1562.7	81.2	43.1
1985	5,512.8	263.6[h]	4.8	825.0	58.1	26.4
Akzo (Netherlands)						
1988	$ 8,374.2	$ 446.0	5.3%	$ 641.4	$ 409.0	71.1
1987	7,652.7	354.6[i]	4.6	539.4	362.1	67.4
1986	6,373.5	366.5[j]	5.7	451.4	304.5	68.4
1985	5,424.7	275.1[k]	5.1	303.6	218.4	65.0
Degussa (West Germany)						
1988	$ 7,730.1	$ 83.0	1.1%	$ 255.3	$ 213.1	32.4
1987	6,510.6	67.2	1.0	230.9	150.0	30.8
1986	5,010.1	53.0	1.1	212.0	108.3	25.0
1985	3,984.4	38.1	1.0	138.4	64.6	23.9
Unilever (Netherlands/U.K.)						
1988	$ 6,986.3	$521.2	7.5%	$573.3	$624.7	48.0
1987	6,026.2	420.8	7.0	421.5	540.3	44.0
1986	4,645.0	300.6	6.5	306.1	414.4	42.6
1985	3,436.2	215.0	6.3	169.9	294.7	40.2
Nestle (Switzerland)						
1988	$ 6,893.3	$410.9[l]	6.0%	$644.5	$293.4	44.3
1987	5,989.8	325.9[m]	5.4	498.3	247.1	45.0
1986	4,842.5	222.3[n]	4.6	517.1	192.6	44.8
1985	3,796.6	187.6[o]	4.9	271.1	131.8	44.5
Roche (Switzerland)						
1988	$ 5,952.3	$439.4	7.4%	$446.6	$828.9	49.7
1987	5,171.1	323.5	6.3	348.8	715.8	47.5
1986	4,345.7	231.1	5.3	293.7	623.7	46.5
1985	3,634.3	183.6	5.1	220.2	486.3	46.5
Hanson Industries (U.K.)						
1988	$ 5,111.6	$399.5[p]	7.8%	$667.7	$181.8	28.6
1987	4,422.6	260.6[q]	5.9	431.0	140.4	27.9
1986	3,670.6	198.0[r]	5.4	329.0	91.8	27.3
1985[s]	7,128.6	142.8	2.0	294.3	57.2	26.1
BOC International (U.K.)						
1989[t]	$ 4,643.4	$248.9[u]	5.4%	$462.6	na	57.0
1988[t]	3,969.2	261.0[v]	6.6	320.3	na	68.5
1987[t]	3,708.0	213.0[w]	5.7	221.0	na	65.4
1986[t]	3,186.1	147.3	4.6	152.5	na	67.7
Imperial Chemical Industries (U.K.)						
1988	$ 3,771.4	$365.1[x]	9.7%	$523.5	$ 83.3	38.8
1987	3,211.6	273.4[y]	8.5	362.5	61.5	35.5
1986	2,851.3	10.7[z]	0.4	347.4	55.7	37.7
1985	2,462.3	179.1[aa]	5.8	312.8	46.2	36.9
Procter & Gamble (U.S.)						
1988	$ 3,488.1	$152.3	4.4%	$176.3	na	22.1
1987	2,195.6	98.1[bb]	4.5	162.9	na	18.1
1986	1,615.5	64.6[cc]	3.3	108.3	na	16.3
1985	1,266.2	11.5	0.9	71.7	na	15.9
Philips (Netherlands)						
1988	$ 2,207.7	$117.4	5.3%	$345.7	na	14.9
1987	1,942.7	64.4	3.3	644.8	na	13.8
1986	1,322.9	56.6	4.3	231.2	na	11.6
1985	1,102.6	53.0	4.8	257.6	na	12.0
BASF (West Germany)						
1988	$ 949.0	$ 35.6[dd]	3.8%	$ 84.9	$ 45.1	na
1987	874.9	39.3[ee]	4.5	72.1	38.2	7.4
1986	659.4	31.5[ff]	4.8	40.2	28.7	6.5
1985	524.3	17.0[gg]	3.2	22.9	19.5	6.4
Imperial Chemical Industries (U.K.)						
1988	$ 918.7	$ 94.7	10.3%	$ 39.7	na	4.6
1987	758.4	80.5[hh]	9.8	27.9	na	4.2
1986	618.2	60.4[ii]	9.8	33.0	na	4.1
1985	481.0	46.2[ii]	9.6	33.0	na	3.6

a Excludes nonrecurring loss of $78.3 million. b Excludes nonrecurring loss of $63.0 million. c Excludes nonrecurring loss of $51.8 million. d Excludes nonrecurring minority interests' loss of $154.4 million. e Net loss. f Excludes nonrecurring gain of $17.6 million. g Excludes nonrecurring minority interests' loss of $68.1 million. h Restated to reflect full acquisition of Hydro Aluminum. i Excludes nonrecurring gain of $134.6 million. j Excludes nonrecurring gain of $9.5 million. k Excludes nonrecurring gain of $0.8 million and minority interests' loss of $22.0 million. l Excludes nonrecurring loss of $136.5 million. m Excludes nonrecurring loss of $90.5 million. n Excludes nonrecurring loss of $83.3 million. o Excludes nonrecurring loss of $50.5 million. p Excludes nonrecurring loss of $87.9 million. q Excludes nonrecurring loss of $40.4 million. r Excludes nonrecurring loss of $22.4 million. s Includes wholly owned DSM-Aardgas. t Fiscal year ends March 31. u Excludes nonrecurring gain of $207.7 million. v Excludes nonrecurring loss of $25.9 million. w Excludes nonrecurring loss of $13.9 million. x Excludes nonrecurring loss of $42.2 million. y Excludes nonrecurring loss of $8.2 million. z Excludes nonrecurring loss of $5.0 million and pretax write-off of $187.7 million. aa Excludes nonrecurring loss of $4.9 million. bb Excludes nonrecurring gain of $17.8 million. cc Excludes nonrecurring loss of $13.2 million. dd Excludes nonrecurring gain of $2.7 million. ee Excludes nonrecurring loss of $3.2 million. ff Excludes nonrecurring loss of $2.3 million. gg Excludes nonrecurring loss of $6.2 million. hh Excludes nonrecurring loss of $1.8 million. ii Excludes nonrecurring gain of $7.8 million. jj Excludes nonrecurring gain of $4.1 million. na = not available.

NOTE ON CURRENCY CONVERSION

For monetary statistics in this section, European currencies were converted to U.S. dollars by the following conversion rates:

	$1.00 (U.S.) is equivalent to:								
	Belgium	France	Italy	Netherlands	Norway	Spain	Sweden	Switzerland	U.K.	West Germany
1988	36.77 francs	5.96 francs	1302 lire	1.98 guilders	6.52 crowns	116.49 pesetas	6.13 crowns	1.46 francs	0.562 pound	1.76 marks
1987	37.33 francs	6.01 francs	1296 lire	2.03 guilders	6.74 crowns	123.48 pesetas	6.34 crowns	1.49 francs	0.610 pound	1.80 marks
1986	44.67 francs	6.93 francs	1491 lire	2.45 guilders	7.39 crowns	140.05 pesetas	7.14 crowns	1.80 francs	0.682 pound	2.17 marks
1985	59.38 francs	8.99 francs	1909 lire	3.32 guilders	8.60 crowns	170.04 pesetas	8.60 crowns	2.46 francs	0.772 pound	2.94 marks
1984	57.78 francs	8.74 francs	1757 lire	3.21 guilders	8.16 crowns	160.76 pesetas	8.27 crowns	2.35 francs	0.748 pound	2.85 marks

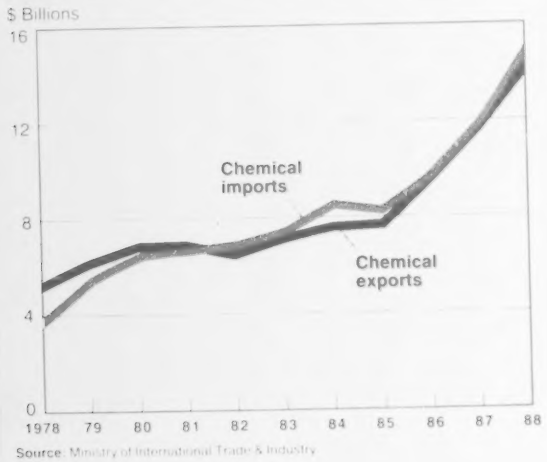
Source: International Monetary Fund

6 Foreign Chemical Industries — Japan

The Japanese economy remained healthy last year, with economic expansion continuing into 1989. Industrial production, for example, was up a stout 10%, an increase about three times greater than in 1987.

As a result, strong domestic demand kept the chemical industry busy throughout the year. Paced by organic chemicals and plastics, chemical output was 8% higher than in 1987. And many of the major Japanese chemical producers racked up markedly wider profit margins during their most recent fiscal year. Although the deficit in Japan's trade balance in chemicals widened just a bit—not surprising considering the strength of the yen—it was not enough in the red to cause alarm.

Slight deficit continues for chemical trade



Source: Ministry of International Trade & Industry

INDUSTRY TRENDS: Output gains

Production index, 1985 = 100	1988	1987	1986	1985	Change 1987-88
All manufacturing	113.1	103.2	99.8	100.0	10%
All chemicals	120.0	111.1	103.2	100.0	8
Inorganic chemicals and pigments	108.4	100.9	98.5	100.0	7
Alkalies and chlorine	110.5	103.6	98.5	100.0	7
Organic chemicals	115.9	105.4	98.5	100.0	10
Petrochemicals	118.0	107.6	100.5	100.0	10
Aromatics	115.9	107.1	99.9	100.0	8
Cyclic intermediates and dyes	121.2	110.9	101.3	100.0	9
Plastics	120.6	109.9	102.5	100.0	10
Synthetic fibers	95.4	94.6	95.9	100.0	1
Synthetic rubber	112.2	102.9	99.6	100.0	9
Fertilizer	88.5	91.6	93.3	100.0	−3
Textile materials	117.8	110.7	103.1	100.0	6
Medicinals and drugs	134.8	123.1	108.8	100.0	10

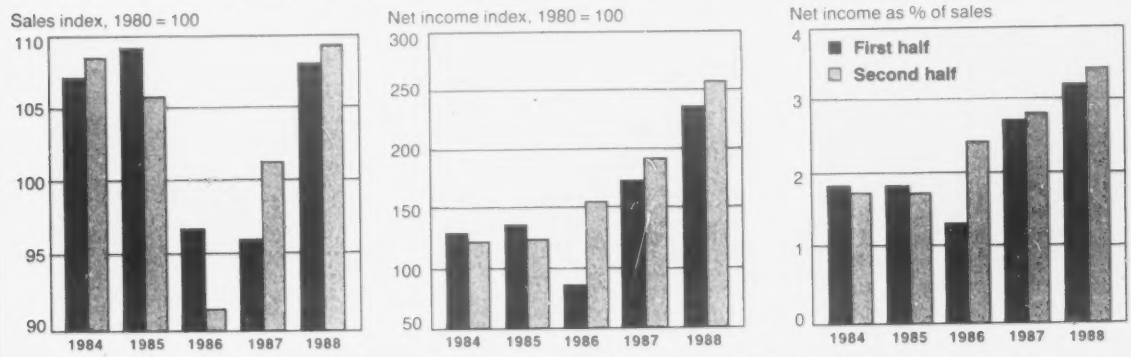
Source: Ministry of International Trade & Industry

PRODUCTION: Up for most chemicals

Thousands of metric tons unless otherwise indicated	1988	1987	1986	1985	Change 1987-88
INORGANIC CHEMICALS					
Ammonia	1817	1784	1794	1981	2%
Ammonium chloride	299	332	364	373	−10
Ammonium sulfate	1834	1804	1784	1837	2
Calcium carbide	342	354	399	441	−3
Calcium superphosphate	476	499	514	529	−5
Carbon black	720	635	616	632	13
Chlorine, liquid	979	911	881	926	7
Hydrochloric acid	565	543	549	549	4
Nitrogen, millions of cu m	6940	6452	6293	6220	8
Oxygen, millions of cu m	7707	6878	6786	7388	12
Sodium carbonate	1083	1098	1022	1057	−1
Sodium hydroxide	3508	3227	3077	3075	9
Sodium silicate	721	664	603	594	9
Sulfuric acid	6766	6541	6561	6580	3
Titanium dioxide	258	238	223	217	8
ORGANIC CHEMICALS					
Acetaldehyde	333	285	254	271	17
Acetic acid	402	377	300	344	7
Acetone	289	260	228	237	11
Acrylonitrile	600	573	546	541	5
Benzene[a]	2374	2226	2071	2084	7
Butadiene	780	707	656	639	10
Butanol	276	259	248	258	7
Caprolactam	493	470	448	455	5
Cyclohexane	561	557	515	524	1
Dioctyl phthalate	273	261	257	241	5
Ethylene	5162	4585	4291	4224	13
Ethylene dichloride	2301	2051	1908	1901	12
Ethylene glycol	349	313	339	440	12
Ethylene oxide	510	484	489	554	5
Methanol	141	181	221	254	−22
Octanol	273	257	235	230	6
Phenol	358	308	260	262	16
Phthalic anhydride[a]	171	172	163	162	−1
Propylene	3682	3370	3167	2980	9
Propylene glycol	265	236	223	219	12
Styrene	1757	1559	1417	1418	13
Terephthalic acid	1150	1048	935	854	10
Toluene	1018	1006	805	803	1
Toluene diisocyanate	96	91	86	84	5
Urea	791	729	778	929	9
Xylene	1988	1767	1570	1523	13
PLASTICS					
Phenolic resins	356	332	313	325	7
Polyethylene	2380	2181	2066	2027	9
Polypropylene	1559	1405	1333	1304	11
Polystyrene	1891	1735	1598	1599	9
Polyvinyl chloride	1838	1663	1540	1550	11
SYNTHETIC RUBBER	1299	1192	1150	1158	9

a Petroleum-based product only. Source: Ministry of International Trade & Industry

Chemical sales are only moderately higher, but profits have swelled, fattening profit margins



Note: Based on results of 12 leading Japanese chemical companies: Asahi Chemical, Dainippon Ink & Chemicals, Hitachi Chemical, Mitsubishi Kasei, Mitsubishi Petrochemical, Mitsui Toatsu Chemicals, Sekisui Chemical, Showa Denko, Sumitomo Chemical, Takeda Chemical Industries, Teijin, and Toray Industries. The fiscal year for most, but not all, of these companies ends March 31. **Source:** Toyo Keizai Shinposha

COMPANY RESULTS

Profitability continues to improve for Japanese chemical producers

$ Millions	Net sales	Net income	Profit margin	Total assets	Employees (thousands)
Asahi Chemical					
1988	$6384	$219.4	3.4%	$6410	15.4
1987	5357	141.0	2.6	5241	15.6
1986	4351	84.6	1.9	4361	15.9
1985	3910	73.3	1.9	3661	15.9
Mitsubishi Kasei					
1988	$6132	$124.9	2.0%	$6973	8.8
1987	4360	90.4	2.1	6002	8.9
1986	3775	42.0	1.1	5014	8.5
1985	3963	33.1	0.8	4016	8.2
Takeda Chemical					
1988	$4567	$269.4	5.9%	$5358	10.8
1987	3777	219.6	5.8	4628	10.8
1986	2951	133.6	4.5	3599	10.8
1985	2331	98.4	4.2	2612	11.0
Sumitomo Chemical					
1988	$4341	$116.4	2.7%	$5806	7.7
1987	3609	78.6	2.2	4615	7.7
1986	3085	29.3	1.0	3949	7.6
1985	3219	38.9	1.2	3277	7.1
Toray Industries					
1988	$4317	$134.7	3.1%	$5528	10.0
1987	3789	113.5	3.0	4854	10.6
1986	3250	67.1	2.1	3947	11.7
1985	3177	78.2	2.5	3326	12.6
Sekisui Chemical					
1988	$3936	$141.4	3.6%	$2919	5.2
1987	3089	84.6	2.7	2555	5.3
1986	2229	31.0	1.4	1732	6.3
1985	1769	22.5	1.3	1439	6.2

$ Millions	Net sales	Net income	Profit margin	Total assets	Employees (thousands)
1988	$3679	$ 71.3	1.9%	$4299	5.1
1987	2908	38.8	1.3	3881	5.0
1986	2116	22.1	1.0	3163	4.8
1985	2066	20.1	1.0	2738	4.6
1988	$3440	$ 62.2	1.8%	$4074	6.7
1987	2923	43.7	1.5	3366	6.6
1986	2336	32.8	1.4	2214	6.3
1985	2102	26.4	1.3	1722	6.2
1988	$3082	$ 83.5	2.7%	$3936	5.4
1987	2543	43.5	1.7	3004	5.6
1986	2110	23.0	1.1	2599	5.6
1985	2102	14.7	0.7	2242	5.4
1988	$2654	$160.0	6.0%	$3493	2.9
1987	2022	64.7	3.2	2843	2.8
1986	1642	25.7	1.6	2073	2.5
1985	2139	22.4	1.1	1939	2.4
1988	$2438	$136.5	5.6%	$3823	5.8
1987	2167	109.3	5.0	3391	6.2
1986	2039	72.0	3.5	2600	6.4
1985	2102	70.9	3.4	2210	7.0
1988	$2158	$ 28.2	1.3%	$1261	5.0
1987	1748	20.7	1.2	1056	4.9
1986	1387	14.1	1.0	891	5.0
1985	1123	9.3	0.8	720	4.9

Note: Monetary statistics are converted from yen to U.S. dollars on the basis of $1.00 equals: 1988, 128 ¥; 1987, 142.9 ¥; 1986, 166.9 ¥; 1985, 204.6 ¥. Year-to-year changes in sales, net income, and assets are affected by these fluctuations in the currency exchange rate. **a** Fiscal year ends March 31. **b** Fiscal year ends March 31 for 1988, Jan. 31 for 1987, 1986, and 1985. **c** Fiscal year ends Dec. 31. **Source:** Toyo Keizai Shinposha

6 Foreign Chemical Industries — Canada

For the Canadian chemical industry, 1988 was a banner year. Hefty demand in home markets, good growth in exports, and higher selling prices for many major products, especially petrochemicals and plastics, combined to bolster companies' financial performance.

It also was a year that witnessed some major shifts in the industry's corporate structure. In April, to better integrate its worldwide chemical business, Britain's ICI acquired sole ownership of C-I-L Inc., the Canadian subsidiary in which it has long held a majority interest, and began a drastic revamping of the Canadian firm's operations by selling off several C-I-L activities that it deemed unessential. And last fall, Nova Corp. of Alberta acquired the major operations of Polysar Energy & Chemical, in the process becoming a world-scale producer of petrochemicals. On the other hand, early this year a bid by Hoechst Celanese, the U.S. arm of West Germany's Hoechst, to buy up the shares in Celanese Canada that it does not already hold failed when too few of the minority shareholders tendered their stock.

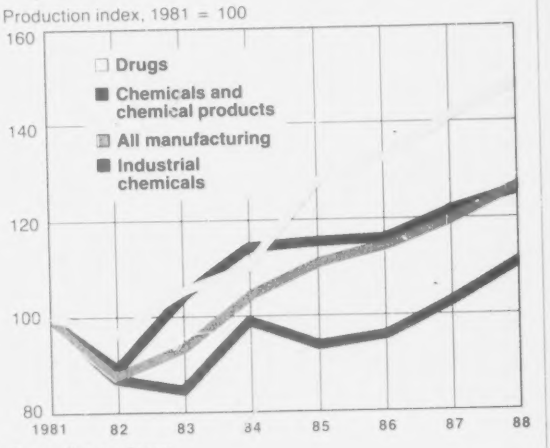
Note on currency conversion: Monetary statistics in this section have been converted from Canadian dollars to U.S. dollars on the basis of $1.00 U.S. equals: 1988, $1.231 Canadian; 1987, $1.322 Canadian; 1986, $1.391 Canadian; 1985, $1.362 Canadian; 1984, $1.308 Canadian; 1983, $1.244 Canadian.

COMPANY RESULTS: Profits continue strong

$ Millions (U.S.)	Sales	Net income[a]	Profit margin	Capital expenditures	Employees (thousands)
Celanese Canada					
1988	$ 330.8	$ 39.7	12.0%	$ 19.9	2.1
1987	265.5	21.5	8.1	16.1	2.1
1986	248.2	13.5	5.5	9.0	2.1
1985	247.7	9.3	3.7	11.2	2.1
Du Pont Canada					
1988	$1130.9	$ 81.2	7.3%	$ 86.6	4.0
1987	1021.4	68.5	6.7	47.9	4.2
1986	893.7	43.4	4.9	67.9	4.6
1985	870.7	15.1	1.7	52.4	4.9
Nova Corp. of Alberta					
1988	$3202	$344	10.8%	$357	na
1987	1755	135	7.7	151	na
1986	1928	78	4.0	234	na
1985	2457	(60)[b]	—	284	na
Union Carbide Canada					
1988	$ 461.3	$ 34.3	7.4%	$ 45.0	2.8
1987	318.4	19.4	6.1	26.1	2.3
1986	258.1	14.5	5.6	29.7	3.3
1985	264.8	11.7	4.4	16.4	3.8

a Excludes extraordinary gains and losses b Net loss na = not available

Expansion continues for chemical output



Source: Statistics Canada

PRODUCTION: Higher for most chemicals

Thousands of metric tons	1988	1987	1986	1985	Change 1987-88
INORGANIC CHEMICALS					
Ammonia	4010	3512	3540	3620	14%
Ammonium nitrate	981	844	948	1075	16
Ammonium phosphate	986	941	1149	1301	5
Carbon black	181	172	154	173	5
Chlorine	1664	1635	1536	1424	2
Hydrochloric acid	180	164	153	158	9
Nitric acid	907	900	1024	1128	1
Phosphoric acid, 100% P_2O_5	475	464	554	629	2
Sodium chlorate	503	432	373	336	17
Sodium hydroxide	1720	1770	1696	1589	−3
Sulfuric acid	3805	3437	3536	3890	11
Zinc oxide	62	44	38	na	40
ORGANIC CHEMICALS					
Benzene	695	720	635	691	−3
Butadiene	183	167	146	132	9
Butylene	148	156	142	133	−5
Ethylene	2346	2140	1909	1745	10
Formaldehyde	123	122	117	na	1
Methanol	2101	1627	1403	na	29
Propylene	669	628	628	647	7
Toluene	417	396	393	472	5
Urea	2372	2142	2330	2033	11
Xylenes	399	345	356	415	16
PLASTICS					
Polyesters, unsaturated	43	47	37	36	−9
Polyethylene, high density	311	270	242	229	15
Polyethylene, low density	1105	1021	887	733	8
Polystyrene[a]	216	197	186	178	9

a Includes acrylonitrile-butadiene-styrene resins na = not available Source: Statistics Canada

SHIPMENTS: Up sharply for organic chemicals and plastics last year

$ Millions (U.S.)	1988	1987	1986	1985	1984	1983	Change 1987-88[a]
All manufacturing	$234,398	$204,019	$179,420	$179,177	$174,373	$163,192	7%
Chemicals and chemical products	18,306	15,239	13,066	12,898	12,821	12,613	12
Industrial chemicals, inorganic	1,888	1,715	1,651	1,605	1,757	1,750	
Industrial chemicals, organic	5,425	3,978	2,725	2,833	2,966	3,102	2
Plastics and synthetic resins	2,098	1,745	1,396	1,317	1,331	1,302	12
Pharmaceuticals and medicinals	2,449	2,094	1,664	1,536	1,468	1,336	9
Adhesives	124	119	111	98	94	92	−3
Paint and varnish	1,303	1,120	951	881	815	784	8
Soaps and cleansers	1,112	995	1,038	1,028	962	940	4
Toilet preparations	879	758	640	626	614	597	8
Printing ink	219	190	209	184	183	172	7
Synthetic fibers	784	695	586	563	568	607	5
Plastic products	4,323	3,620	2,890	2,700	2,633	2,448	11

a In Canadian dollars. **Source:** Statistics Canada

CHEMICAL IMPORTS: A fourth are organics

$ Millions (U.S.)	1988	1987	1986	1985
Inorganic chemicals	$ 566	$ 396	$ 377	$ 374
Organic chemicals	1561	1270	1162	1107
Fertilizers and fertilizer materials	197	158	143	152
Synthetic and reclaimed rubber	228	202	169	160
Plastic materials	1097	831	702	651
Plastic film and sheet	392	372	306	278
Other plastic shapes and forms	431	261	233	214
Dyes, except dyeing intermediates	86	71	58	49
Pigments, lakes, and toners	112	115	95	78
Paints and related products	195	176	132	127
Other chemical products	960	857	822	807
TOTAL	$5825	$4708	$4199	$3997
Imports from U.S.	$4330	$3586	$3145	$3034
U.S. share	74%	76%	75%	76%

Source: Statistics Canada

CHEMICAL EXPORTS: Organics, plastics soar

$ Millions (U.S.)	1988	1987	1986	1985
Chemical elements	$ 199	$ 167	$ 173	$ 158
Other inorganic chemicals	1135	908	882	828
Organic chemicals	1518	1029	826	995
Fertilizers and fertilizer materials	1351	960	835	946
Synthetic rubber and plastic materials	1265	858	632	587
Plastics, basic shapes and forms	381	380	327	238
Other chemical products	376	338	294	236
TOTAL	$6226	$4639	$3968	$3988
Exports to U.S.	$3927	$2938	$2625	$2669
U.S. share	63%	63%	66%	67%

Source: Statistics Canada

TRADE BALANCE: Overall surplus down . . .

$ Billions (U.S.)	1988	1987	1986	1985	1984
Total exports	$109.0	$91.8	$83.9	$85.3	$83.8
Total imports	106.5	87.9	80.9	77.1	73.2
Trade balance	2.5	3.9	3.0	8.2	10.6

. . . but chemical trade becomes positive

$ Millions (U.S.)	1988	1987	1986	1985	1984
Chemical exports	$6226	$4639	$3968	$3988	$4054
Chemical imports	5825	4708	4199	3997	3986
Chemical trade balance	401	−69	−232	−9	68

Source: Statistics Canada

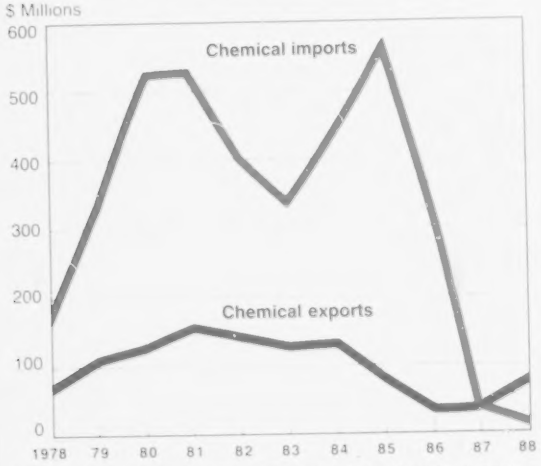
PRICES: Big hikes in organics, plastics

Price index, 1981 = 100	1988	1987	1986	Change 1987-88
All commodities	127.9	122.8	119.6	4%
Chemicals and chemical products	131.3	119.7	116.0	10
Inorganic industrial chemicals	116.0	111.6	113.4	4
Sulfuric acid	133.6	130.6	125.2	2
Chlorine	130.8	130.4	128.5	0
Ammonia	79.6	78.9	89.7	1
Organic industrial chemicals	116.9	95.0	90.0	23
Benzene-toluene-xylene	67.4	70.1	68.5	−4
Olefins	114.7	79.5	76.9	44
Synthetic resins	141.0	118.0	110.4	19
Polyethylene[a]	147.1	105.6	96.5	39
Polystyrene	146.4	122.7	93.9	19
Thermosets	133.0	116.1	108.3	15
Synthetic fibers	103.5	101.7	100.1	2
Agricultural chemicals	112.9	111.8	111.4	1
Mixed fertilizers	107.2	97.9	97.3	9
Pharmaceuticals	169.4	160.3	150.0	6
Paint and varnish	134.9	130.5	129.4	3
Soaps and cleansers	132.3	127.7	123.3	4
Toilet preparations	159.3	152.2	146.3	5
Pigments, lakes, and toners	126.8	120.2	119.5	5
Inks	112.4	110.7	111.4	2

a Includes both high and low density. **Source:** Statistics Canada

6 Foreign Chemical Industries — **Mexico**

Pemex hikes exports and slashes imports



Note: Trade by Pemex of primary petrochemicals only. Does not include secondary chemicals. Import statistics for 1987 and 1988 reflect the fact that private companies, as well as Pemex, can now import primary petrochemicals directly.
Source: Petroleos Mexicanos

IMPORTS: Pemex has slashed foreign buying

Thousands of metric tons[a]	1988	1987	1986	1985	1984
Acetaldehyde	0	0	26	70	70
Acrylonitrile	0	0	36	50	34
Ammonia	0	151	13	39	0
Butadiene	0	0	44	97	67
Cyclohexane	0	0	19	33	26
Dichloroethane	0	0	0	0	57
Dodecylbenzene	0	0	5	39	49
Ethylbenzene	2	3	0	6	16
Ethylene oxide	0	0	2	48	11
Isopropyl alcohol	0	0	26	50	44
Perchloroethylene	0	0	15	14	15
Polyethylene, high density	2	1	82	42	19
Polyethylene, low density	2	1	76	127	63
Propylene	20	22	26	26	26
Propylene tetramer	4	6	47	19	12
Styrene	0	0	49	112	93
Toluene	0	0	47	43	37
Vinyl chloride	0	0	100	162	109
o-Xylene	0	0	7	9	0
p-Xylene	0	0	114	179	119

a Imports by Petroleos Mexicanos (Pemex) of primary petrochemicals; see note for graph above. Source: Pemex

PRODUCTION: Up for most petrochemicals

Thousands of metric tons[a]	1988	1987	1986	1985	Change 1987–88
Acetaldehyde	156	158	136	145	−1%
Acrylonitrile	61	58	54	49	5
Ammonia, anhydrous	2515	2121	1949	2261	19
Benzene	271	282	222	178	−4
Butadiene	12	21	18	18	−43
Cyclohexane	42	52	39	32	−19
Cumene	48	38	42	39	26
Dichloroethane	330	326	271	193	1
Dodecylbenzene	111	98	103	61	13
Ethane	2927	2518	2550	1905	16
Ethylbenzene	159	152	91	46	5
Ethylene	916	804	767	670	14
Ethylene oxide	102	95	114	71	7
Hexane	70	98	101	98	−29
Hydrochloric acid	118	117	83	63	1
Isopropyl alcohol	14	17	11	14	−18
Methanol	201	191	182	192	5
Nitrogen	62	49	49	46	27
Oxygen	241	179	206	211	35
Polyethylene, high density	82	76	69	67	8
Polyethylene, low density	317	275	242	160	15
Propylene	281	257	232	207	9
Propylene tetramer	108	76	51	31	42
Styrene	131	121	69	33	8
Sulfur, recovered	510	501	456	475	2
Toluene	309	313	238	220	−1
Vinyl chloride	175	179	141	108	−2
m- and *p*-Xylene	322	313	231	247	3
o-Xylene	68	68	42	44	0

a Production by Petroleos Mexicanos (Pemex) of primary petrochemicals. Source: Pemex

DOMESTIC SALES: Few big changes last year

Thousands of metric tons[a]	1988	1987	1986	1985	Change 1987–88
Acetaldehyde	153	157	150	199	−3%
Acrylonitrile	62	58	91	96	7
Ammonia, anhydrous	1936	1909	1857	1804	1
Benzene	13	14	13	17	−7
Butadiene	11	18	68	110	−39
Cyclohexane	41	51	55	62	−20
Dodecylbenzene	107	92	102	100	16
Ethylene oxide	97	94	109	118	3
Hexane	49	48	37	48	2
Isopropyl alcohol	13	16	42	61	−9
Methanol	185	160	176	176	16
Polyethylene, high density	82	78	119	134	5
Polyethylene, low density	307	296	282	266	4
Styrene	126	119	123	140	6
Sulfur	508	497	462	457	2
Toluene	87	77	90	97	13
Vinyl chloride	172	173	261	275	−1
o-Xylene	67	63	43	38	6
p-Xylene	193	203	226	268	−5

a Domestic sales by Petroleos Mexicanos (Pemex) of primary petrochemicals. Source: Pemex

6 Foreign Chemical Industries — Eastern Europe

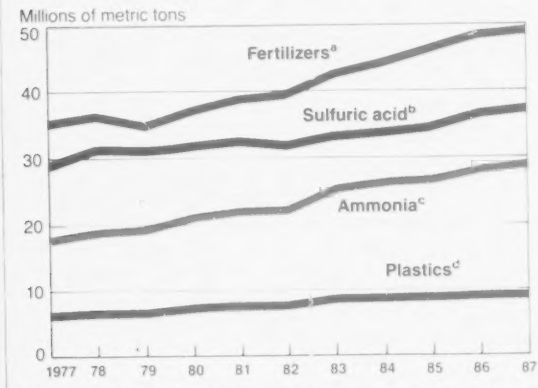
Last year, overall industrial output in Eastern Europe and the Soviet Union rose nearly 4%, about the same as in 1987 but well below the expansion of almost 5% in 1986. Growth also fell short of the region's target of 4.3% for 1988. Growth in chemical production in 1988 was merely 2% in Czechoslovakia and practically nil in Hungary, reflecting the general industrial slowdown in both countries. The Soviet chemical industry grew more slowly than in recent years, as well. Poland's industry showed the fastest growth in the region.

MAN-MADE FIBERS: Strong growth for noncellulosics in Soviet Union and Hungary

Production, thousands of metric tons	1987	1986	1985	1984	Change 1986–87
NONCELLULOSIC FIBERS					
Bulgaria	83	81	71	68	2%
Czechoslovakia	132	128	115	107	3
East Germany	161	159	146	144	1
Hungary	24	21	22	21	12
Poland	151	148	149	144	2
Romania	202	200	197	174	1
U.S.S.R.	836	758	713	658	10
TOTAL	**1588**	**1495**	**1412**	**1317**	6%
CELLULOSIC FIBERS					
Bulgaria	43	42	42	41	1%
Czechoslovakia	62	62	60	59	1
East Germany	128	128	168	170	1
Hungary	6	6	6	7	2
Poland	73	72	71	76	1
Romania	66	64	62	60	3
U.S.S.R.	592	589	586	602	0
TOTAL	**970**	**962**	**994**	**1014**	1%

a Excludes olefins and glass fiber. **Source:** Fiber Economics Bureau

Output edges higher for major chemical products in Eastern Europe



Note: Data for U.S.S.R., Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, and Romania. a As N, P_2O_5, and K_2O. b 100% H_2SO_4. c Nitrogen content. d Including resins for man-made fibers in U.S.S.R. **Sources:** Central Intelligence Agency, Department of Agriculture, PlanEcon Inc., official national statistics from state central statistical bureaus

PRODUCTION GROWTH: Slower for chemicals in the Soviet Union

% annual change in gross output	1988	1987	1986	1985	1984
U.S.S.R. and East Europe					
All industry	3.9%	3.8%	4.8%	3.9%	4.3%
Bulgaria					
All industry	5.1	4.2	4.0	3.2	4.2
Chemicals	5.0	5.1	4.9	3.6	8.2
Czechoslovakia					
All industry	2.0	2.5	3.2	3.5	4.0
Chemicals	1.9	3.2	4.0	5.1	4.5
East Germany					
All industry[a]	3.7	3.2	3.8	4.4	4.2
Chemicals	4.0	2.6	2.2	3.7	4.3
Hungary					
All industry	−0.4	3.5	1.9	0.7	3.2
Chemicals[b]	0.3	5.8	1.1	0.8	4.4
Poland					
All industry	5.4	3.4	4.7	4.5	5.2
Chemicals	6.5	4.3	4.2	3.0	5.0
Romania					
All industry	3.6	4.5	7.7	4.9	6.7
Chemicals	3.0	−4.1	8.3	0.3	8.1
U.S.S.R.					
All industry[c]	3.9	3.9	4.9	3.9	4.1
Chemicals[c]	3.8	4.4	6.3	5.0	5.1
All industry[d]	na	1.5[e]	2.6	1.8	2.5
Chemicals[d]	na	3.2[e]	4.6	4.1	3.2

a Industrial commodity production. b For state and cooperative industry only. c Figures based on official Soviet statistics. d Figures based on Central Intelligence Agency estimates, giving lower results because of postulated upward bias in official figures. e Preliminary figure. na = not available. **Sources:** United Nations Economic Commission for Europe and state central statistical bureaus, Central Intelligence Agency

AGRICULTURAL CHEMICALS: Supplies up modestly for fertilizers in the Soviet Union

Thousands of metric tons	1988	1987	1986	1985	1984
Bulgaria					
Fertilizer supply[a]	na	745	808	865	938
Pesticide supply[b]	na	28.5	36.5	35.6	35.6
Czechoslovakia					
Fertilizer supply[a]	na	1,557	1,689	1,734	1,749
East Germany					
Fertilizer supply[a]	na	1,664	1,642	1,639	1,565
Pesticide supply[b]	na	29.9	29.4	26.7	26.0
Hungary					
Fertilizer supply[a]	na	1,373	1,383	1,338	1,524
Poland					
Fertilizer supply[a]	3,296	3,583	3,413	3,280	3,424
Pesticide supply[b]	23.0	18.4	14.5	12.4	11.1
Romania					
Fertilizer supply[a]	na	na	1,386	1,374	1,289
U.S.S.R.					
Fertilizer supply[a]	27,100	27,412	26,514	25,395	23,080
Nitrogen[a]	11,700[c]	11,787	11,475	10,950	10,279
Phosphate[a,d]	8,487[c]	8,564	8,354	7,615	6,625
Potassium[a]	6,904[c]	7,052	6,677	6,822	6,167

a Nutrient content basis, as N, P_2O_5, or K_2O. b On basis of active substance. c Estimated. d Includes ground phosphate rock. na = not available. **Sources:** Department of Agriculture, Central Intelligence Agency, official national statistics from state central statistical bureaus

PRODUCTION: Growth has been limited in recent years for some major chemicals

Thousands of metric tons, unless otherwise noted	1988[a]	1987	1986	1985	1984
U.S.S.R.					
Sulfuric acid	na	28,531	27,847	26,037	25,338
Mineral fertilizers[b]	37,100	36,334	34,737	33,194	30,808
Nitrogen[b]	16,000[a]	15,743	15,221	14,223	13,328
Phosphate[b,c]	9,901[a]	9,697	9,279	8,596	7,695
Potassium[b]	11,190[a]	10,888	10,228	10,367	9,776
Synthetic ammonia[d]	na	20,470	19,590	18,232	17,677
Plastics[e]	5,876	5,486	5,345	5,019	4,819
Sodium hydroxide	na	3,288	3,229	3,056	2,972
Ethylene	na	2,930	2,799	2,667	2,543
Methanol	na	3,284	3,219	2,850	2,467
Synthetic rubber[f]	na	2,360	2,320	2,125	2,085
Pesticides[g]	na	327	332	348	343
BULGARIA					
Sulfuric acid	780	689	807	810	908
Mineral fertilizers[b]	767	571	580	640	690
Nitrogen[b]	588	443	448	469	479
Phosphate[b]	178	128	132	172	211
Synthetic ammonia[d]	na	1,070	1,091	1,138	1,138
Plastics	na	312	420	406	430
Sodium hydroxide	129	104	138	151	163
Synthetic rubber	na	25	25	26	26
Pesticides[g]	na	15	15	18	20
CZECHOSLOVAKIA					
Sulfuric acid	1,249	1,264	1,292	1,297	1,246
Mineral fertilizers[b]	na	984	1,041	962	1,136
Nitrogen[b]	596	596	614	526	576
Phosphate[b,c]	313	277	307	310	344
Potassium[b,g]	na	111	120	126	216
Synthetic ammonia[d]	na	950	930	994	827
Plastics	1,192	1,152	1,140	1,103	1,039
Sodium hydroxide	na	338	335	331	329
Synthetic rubber	na	75	76	70	71
Pesticides[g]	na	18	20	19	17
EAST GERMANY					
Sulfuric acid	na	866	883	883	885
Mineral fertilizers[b]	na	5,119	5,046	4,842	4,732
Nitrogen[b]	1,383	1,318	1,252	1,078	959
Phosphate[b,c]	na	291	309	299	308
Potassium[b]	na	3,510	3,485	3,465	3,465
Synthetic ammonia[d]	na	1,179	1,197	1,210	1,207
Plastics	na	1061	1045	1048	1056
Sodium hydroxide	na	577	638	667	694
Synthetic rubber	na	85	118	140	152
Pesticides[g]	na	59	62	60	58
HUNGARY					
Sulfuric acid	512	573	543	520	549
Mineral fertilizers[b]	na	1067	1040	1066	1100
Nitrogen[b]	na	667	655	684	675
Phosphate[b]	na	283	267	252	286
Potassium[b,h]	na	117	118	130	139
Synthetic ammonia[d]	na	785	763	790	813
Plastics	581	539	426	389	385
Ethylene	264	270	269	271	265
Sodium hydroxide[i]	202	201	202	194	194
POLAND					
Sulfuric acid	3166	3149	2965	2863	2769
Mineral fertilizers[b]	na	2622	2526	2270	2356
Nitrogen[b]	1622	1543	1445	1254	1369
Phosphate[b]	962	943	948	883	869
Potassium[b,h]	na	137	133	127	118
Synthetic ammonia[d]	na	1791	1747	1490	1499
Plastics	720	641	632	603	601
Sodium hydroxide	444	425	427	414	379
Ethylene	na	276	279	261	256
Synthetic rubber	127	117	116	126	119
ROMANIA					
Sulfuric acid	na	1693	1971	1835	1915
Mineral fertilizers[b]	na	2897	3278	3097	3073
Nitrogen[b]	na	na	2315	2197	2212
Phosphate[b]	na	na	849	788	765
Synthetic ammonia[d]	na	2784	3037	2876	2857
Plastics	na	638	664	628	655
Sodium hydroxide	na	817	846	814	805
Ethylene	na	319	312	307	317
Synthetic rubber	164	152	162	156	159
Pesticides[g]	na	41	53	53	53

a Approximate figures or estimates. b Nutrient content basis, as N, P_2O_5, or K_2O. c Including production of ground phosphate rock for direct applications and phosphate animal feeds. d Nitrogen content. e Including resins for man-made fibers. f Estimated. g On basis of active substance. h Imported potash added to domestically produced nitrogen and phosphate to form multinutrient fertilizer. i Including regenerated NaOH. na = not available. **Sources:** Central Intelligence Agency, Department of Agriculture, PlanEcon, Inc., official national statistics from state central statistical bureaus.

SOVIET FOREIGN TRADE: Surplus sharply lower as imports swell

$ Millions	1988[a]	1987[b]	1986	1985	1984	1983	1982	1981	1980	1979	1978
Exports[b]	$108,727	$107,664	$97,053	$87,196	$91,495	$91,652	$87,168	$79,380	$76,437	$64,912	$52,435
Imports[b]	105,365	95,969	88,874	83,315	80,409	80,445	77,846	73,194	68,473	57,958	50,798
Trade balance	3,362	11,695	8,179	3,881	11,086	11,207	9,322	6,186	7,964	6,954	1,637
Chemical exports[b]	na	na	2,770	2,837	2,707	2,307	2,203	2,275	2,025	1,606	1,284
Chemical imports[b]	na	na	3,990	3,774	3,256	3,216	3,028	3,211	3,275	2,803	2,188
Chemical trade balance	na	na	−1,220	−937	−549	−909	−825	−1,651	−1,250	−1,197	−904

a Preliminary values. b f.o.b. on board. na = not available. **Sources:** Central Intelligence Agency, U.S.-U.S.S.R. Trade & Economic Council, based on official Soviet statistics and exchange rates.

6 Foreign Chemical Industries — Western Pacific

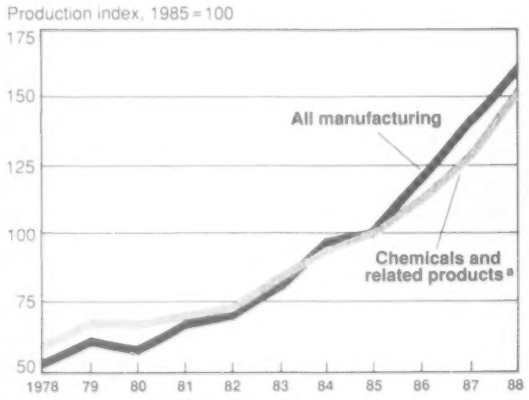
SOUTH KOREA

INDUSTRY TRENDS: 1988 brought big gains

Index, 1985 = 100	1988	1987	1986	1985	Change 1987–88
Chemicals, petroleum, coal					
Production	153.0	129.0	113.4	100.0	19%
Shipments	147.6	124.7	111.8	100.0	18
Inventories	128.5	112.8	109.9	100.0	14
Industrial chemicals					
Production	149.7	127.3	111.9	100.0	18
Shipments	146.1	128.1	113.9	100.0	14
Inventories	116.9	104.3	99.2	100.0	12
Other chemical products					
Production	171.9	131.4	107.6	100.0	31
Shipments	166.3	133.8	109.5	100.0	24
Inventories	161.9	122.0	113.8	100.0	33
Rubber products					
Production	155.0	138.0	122.9	100.0	12
Shipments	155.0	137.4	121.4	100.0	13
Inventories	138.9	119.3	114.3	100.0	16
Plastic products					
Production	173.2	159.2	130.4	100.0	9
Shipments	158.1	154.5	127.2	100.0	2
Inventories	131.9	137.6	126.3	100.0	−4
All manufacturing					
Production	164.7	144.7	121.6	100.0	14
Shipments	162.2	143.2	121.1	100.0	13
Inventories	134.8	118.6	107.9	100.0	14

Source: Bureau of Statistics of the Korean Economic Planning Board

South Korea's industrial expansion continues to surge



a Includes petroleum, coal, rubber, and plastic products
Source: Bureau of Statistics of Korean Economic Planning Board

FOREIGN TRADE: Chemical deficit widened

$ Millions	1988	1987	1986	1985
Exports[a]	$60,696	$47,281	$34,714	$30,283
Imports[b]	51,811	41,020	31,584	30,136
Trade balance	8,886	6,261	3,130	−853
Chemical exports	1,879	1,321	1,068	936
Chemical imports	6,282	4,595	3,495	2,789
Chemical trade balance	−4,404	−3,274	−2,427	−1,853

a Free on board. b Includes cost, insurance, freight. **Source:** Korean Office of Customs Administration

PRODUCTION: Some sharp increases

Thousands of metric tons	1988	1987	1986	1985	Change 1987–88
Complex fertilizers	2038	1966	1872	1960	4%
Urea fertilizers	1000	911	812	839	10
Ethylene	609	576	534	562	6
Polyvinyl chloride	455	451	472	411	1
Polyethylene	572	469	376	353	22
Polyester fibers	593	503	426	390	16
Polypropylene	518	348	263	259	49
Propylene	351	328	307	318	7
Sodium hydroxide	311	262	259	235	19
Benzene	308	339	301	216	−9
Synthetic detergents	275	211	167	139	31

Source: Bureau of Statistics, Korean Economic Planning Board

AUSTRALIA

PRODUCTION: Higher for most chemicals

Thousands of metric tons	1988[a]	1987[a]	1986[a]	1985[a]	Change 1987–88
Chemicals					
Hydrochloric acid, 100%	68	62	54	58	10%
Nitric acid, 100%	204	203	193	200	0
Sulfuric acid, 100%	1816	1678	1788	1773	8
Ammonium sulfate	179	165	205	243	8
Superphosphate[b]	3194	2769	2610	2586	15
Plastics and resins	990	905	885	na	9
Synthetic detergents	271	254	239	226	7
Unsupported plastics film, sheeting	186	175	162	157	6
Polyethylene[c]	137	128	120	118	7
Polyvinyl chloride[d]	16	16	15	14	−4

a Year ending June 30. b Includes double and triple superphosphates and ammonium phosphate expressed in terms of single phosphate (22% P_2O_5 equivalent). c Low and high density. d Including copolymers. na = not available. **Source:** Australian Bureau of Statistics

FOREIGN TRADE: Chemical trade deficit up

$ Millions	1988[a]	1987[a]	1986[a]	1985[a]
Exports[b,c]	$29,837	$23,724	$22,969	$23,104
Imports[d]	29,579	24,546	24,288	22,591
Trade balance	258	−822	−1,319	513
Chemical exports[b,c]	650	440	415	422
Medicinal products	149	110	103	95
Chemical imports[d]	3,117	2,302	2,119	1,982
Organic chemicals	806	584	537	523
Inorganic chemicals	378	213	174	147
Medicinal products	472	337	275	228
Chemical trade balance	−2,467	−1,862	−1,704	−1,560

Note: Monetary statistics converted from Australian to U.S. dollars on basis of $A1.00 equals: 1985, $0.7777; 1986, $0.7006; 1987, $0.6630; 1988, $0.7287. a Year ending June 30. b Free on board. c Includes re-exports. d Values for customs purposes; free-on-board basis. **Source:** Australian Department of Foreign Affairs & Trade

6 Foreign Chemical Industries — Eastern Asia

CHINA

PRODUCTION: Further expansion during 1988 paced by ethylene

Thousands of metric tons, unless otherwise noted	1988	1987	1986	1985	Change 1987–88
Fertilizer[a]	17,675	17,032	13,966	13,222	4%
Synthetic ammonia	19,725	19,486	17,195	17,212	1
Sulfuric acid	10,981	9,620	7,631	6,764	14
Sodium hydroxide	2,925	2,735	2,270	2,353	7
Sodium carbonate	2,593	2,372	2,150	2,011	9
Plastics	1,552	1,432	1,322	1,234	8
Man-made fibers	1,284	1,157	1,016	945	11%
Synthetic detergents	1,290	1,192	1,150	1,005	8
Ethylene	1,231	839	642	651	47
Pesticides	202	157	223	211	28
Pharmaceuticals	194	154	107	58	26
Rubber tires[b]	29,276	24,478	19,932	18,527	20

a Nutrient content. b In thousands of units, not including wheelbarrow and bicycle tires. na = not available. **Sources:** State Statistical Bureau of the People's Republic of China, *China Daily*, *China Economic News*, Central Intelligence Agency

CHEMICAL IMPORTS: Big increases last year

$ Millions[a]	1988	1987	1986	Change 1987–88
Organic chemicals	$1701	$ 998	$ 781	71%
Inorganic chemicals	448	422	330	6
Dyeing, tanning, coloring materials	237	202	158	17
Medicinal and pharmaceutical products	384	229	149	67
Fertilizers[b]	2335	1399	678	67
Plastic materials, resins, cellulose esters and ethers	3558	1470	1216	142
TOTAL	$9139	$5008	$3533	82%

a Includes cost, insurance, and freight. b Manufactured. **Source:** General Administration of Customs of the People's Republic of China

CHEMICAL EXPORTS: Expansion continues

$ Millions[a]	1988	1987	1986	Change 1987–88
Organic chemicals	$ 575	$ 500	$ 386	15%
Inorganic chemicals	762	553	357	38
Dyeing, tanning, coloring materials	229	175	117	31
Medicinal and pharmaceutical products	468	408	317	15
Essential oils, perfumes, cleansing materials	183	136	102	34
Explosives, pyrotechnic products	298	183	144	63
TOTAL	$2897	$2235	$1629	30%

a Free on board. **Source:** General Administration of Customs of the People's Republic of China

TAIWAN

INDUSTRY TRENDS: Chemical growth slows

Industrial production indexes, 1981 = 100	1988	1987	1986	1985	Change 1987–88
All manufacturing	182.6	175.3	155.0	133.5	4%
Chemical materials	191.6	188.1	179.0	149.0	2
Basic chemicals	135.0	140.5	143.7	125.7	−4
Petrochemicals	164.8	167.4	170.6	154.7	−2
Fertilizers	90.8	83.7	85.8	65.6	8
Synthetic fibers	215.8	207.8	185.2	146.7	4
Plastics and resins	240.1	230.0	212.3	164.6	4
Chemical products	219.4	197.3	178.2	153.7	11

Source: Taiwan Ministry of Economic Affairs

FOREIGN TRADE: Chemical imports up 35%

$ Millions	1988	1987	1986	1985
Exports[a]	$60,587	$53,339	$39,786	$30,717
Imports[b]	49,650	34,502	24,175	20,107
Trade balance	10,937	18,837	15,611	10,610
Chemical exports[a,c]	2,448	1,760	1,487	1,340
Chemical imports[b,c]	7,231	5,341	4,163	2,967
Chemical trade balance	−4,783	−3,581	−2,676	−1,627

Note: Statistics converted from NT$ to U.S. dollars on basis of $1.00 equals: 1988, NT$28.6; 1987, NT$31.8; 1986, NT$37.9; 1985, NT$39.8. a Free on board. b Includes cost, insurance, and freight. c Includes chemicals and chemical products, but not plastic and rubber products. **Sources:** Taiwan Council for Economic Planning & Development, C&EN estimates

PRODUCTION: Mixed results for 1988

Thousands of metric tons, unless otherwise noted	1988	1987	1986	1985	Change 1987–88
Man-made fibers	1586	1529	1359	1112	4%
Sulfuric acid	756	742	815	733	2
Polyvinyl chloride	807	832	795	633	−3
Vinyl chloride	725	710	668	511	2
Ammonium sulfate	485	485	604	507	0
Ammonia, anhydrous	338	296	323	252	14
Sodium hydroxide	333	378	366	387	−12
Compound fertilizer	361	335	302	249	8
Hydrochloric acid	257	265	256	228	−3
Urea	306	244	214	139	25
Calcium superphosphate	212	259	248	132	−18
Ethylene glycol	208	202	222	199	3
Oxygen[a]	450	505	506	347	−11
Polyethylene[b]	395	384	398	350	3
Paints	247	229	184	130	8
Dioctyl lactam	178	205	196	142	−13
Styrene	331	310	243	234	7
Acrylonitrile	144	125	150	137	15
Acrylonitrile-butadiene-styrene	234	162	119	52	44

a Millions of cubic meters. b High and low density. **Sources:** Taiwan Council for Economic Planning & Development

ACS Committee on Professional Training 1988 Annual Report

The number of bachelor's degree graduates in chemistry from colleges and universities whose undergraduate chemistry programs are approved by the American Chemical Society decreased 6.8% in the 1987–88 academic year from the previous year. The number of master's degrees from these departments decreased 3.3%, and the number of Ph.D. degrees continued to rise for the ninth year in a row, this year less than 1%. These departments project that in 1989 the number of degrees will increase at all three levels—bachelors 5.9%, masters 15.2%, and Ph.D.s 15%. (It should be noted, however, that these projections are usually higher than actual counts a year later.)

The percentage of baccalaureate graduates certified to ACS was a little over 41%, about the same as last year. (Certified graduates are those who have completed the curriculum specified by the Committee on Professional Training and are eligible for full membership in ACS; noncertified graduates may become associate members of ACS upon graduation and full members after three years of professional experience or a higher degree in a chemical science.)

Of the total of 8271 bachelor's degree graduates from the approved schools, 2074 were reported as planning to go to graduate school, and 1739 to professional schools.

A tabulation of the numbers of bachelor's degrees (certified and noncertified), master's degrees, and Ph.D. degrees awarded in 1987–88 by institutions whose chemistry programs are ACS-approved may be found at the end of this report. The data are summarized in the two smaller tables. These tables also include numbers of chemical engineering graduates from institutions whose programs are accredited by the American Institute of Chemical Engineers and the Accreditation Board for Engineering & Technology. (Note: These departments are not required to report their data to CPT, so the number of departments included varies each year.) Included for the fifth year is a table with information on graduate student enrollments in chemistry departments whose undergraduate programs are ACS-approved.

The number of bachelor's degrees in chemical engineering from the 128 AIChE-ABET-accredited departments that reported in 1988 decreased 24% from the total reported by 107 departments in 1987, the fifth decrease in a row. These 128 departments reported an expected increase in bachelor's degrees of 1.5% in 1989. At the graduate level, the number of chemical engineering master's degrees decreased for the third year, and the number of Ph.D. degrees increased for the ninth year in a row. The number of master's degrees was down 28% from 1987, and the number of Ph.D.s was up 13.6%. Projected 1989 numbers of degrees in chemical engineering from these schools are up 9% for master's degrees and up 17% for Ph.D.s.

The chemistry programs at ACS-approved schools normally are reevaluated at five-year intervals. There were 590 colleges and universities on the approved list at the end

Summary of data from approved schools, 1984–88

	Bachelors				Masters		Doctorates	
	Number of schools	Graduates (totals)	Certified graduates	Noncertified graduates	Number of schools	Graduates	Number of schools	Graduates
CHEMISTRY								
1984	577	9819	4201	5618	321	1637	189	1777
1985	579	9679	4021	5658	316	1621	186	1806
1986	580	9295	3892	5403	315	1620	187	1885
1987	582	8848	3663	5185	316	1636	188	1936
1988	584	8271	3428	4843	319	1584	192	1955
CHEMICAL ENGINEERING[a]								
1984	120	6866	6866	—	114	1436	101	357
1985	123	6442	6442	—	118	1489	104	418
1986	118	5229	5229	—	116	1244	103	460
1987	107	4435	4435	—	103	1078	90	533
1988	128	3577	3577	—	124	1049	106	617

a Chemical engineering departments are not required to report their data to CPT, so the number of departments included in this category varies from year to year

Summary of totals from 1988 reports from approved schools

	Schools reporting	Men	Women	Total
CHEMISTRY				
Bachelors, Total	584	5033	3238	8271
Certified		2102	1326	3428
Noncertified		2931	1912	4843
Masters	319	1054	530	1584
Doctorates	192	1504	451	1955
CHEMICAL ENGINEERING				
Bachelors, Certified	128	2653	924	3577
Masters	124	861	188	1049
Doctorates	106	538	79	617

Graduate student enrollments in departments whose undergraduate chemistry programs are ACS approved

	Number of departments	First-year graduate students		All graduate students	
		Full time	Part time	Full time	Part time
M.S. departments[a]					
Fall 1984	131	468	270	1099	990
Fall 1985	129	417	292	1106	962
Fall 1986	128	474	264	1190	1051
Fall 1987	127	406	315	1136	993
Ph.D. departments					
Fall 1984	186	3404	227	14,194	1314
Fall 1985	187	3455	208	14,379	1372
Fall 1986	187	3475	235	14,438	1355
Fall 1987	192	3441	201	15,212	1231

a Departments whose highest offering is the master's degree in chemistry.

of 1988. During the year the committee studied the chemistry programs of 227 of the approved schools and of 23 schools applying for ACS approval. Each evaluation involved a review of extensive documentary materials submitted by the department chairman describing the current status of the program.

Committee members, 1988

Alice J. Cunningham, *chairman*
Agnes Scott College
Henry A. Bent
North Carolina State University
Norman C. Craig
Oberlin College
Marjorie C. Caserio
University of California, Irvine
Michael P. Doyle
Trinity University
C. David Gutsche
Washington University
Gordon A. Hamilton
Pennsylvania State University
Gordon G. Hammes
Cornell University
Herbert D. Kaesz
University of California, Los Angeles
Karen W. Morse
Utah State University
Shalaby W. Shalaby
Ethicon Inc.
Richard P. Van Duyne
Northwestern University
Barbara A. Gallagher,
committee secretary
Cathy A. Nelson, *staff associate*
Dolphine S. Hite, *program assistant*
American Chemical Society

Six schools were added to the ACS-approved list by the ACS Committee on Professional Training in 1988; five were put on probation; one was removed from probation; two continued on probation; and none was removed from the list.

In 1988 the committee approved an Extension of the Guidelines for Undergraduate Professional Education in Chemistry. The 1988 extension pertains to curriculum options for certifiable degrees in chemistry with an emphasis in biochemistry, polymer chemistry, and/or chemistry education. One of the most important goals in developing the 1988 extension was to emphasize the flexibility in curricular organization for certifiable degrees. An approved department may choose to expand its certifiable degree options to include those described in the 1988 extension, but there is no obligation to do so. Two biochemistry applications were approved. Departments may obtain application forms for the options from the Office of Professional Training at ACS headquarters. Other options under consideration include materials chemistry and chemical physics.

The committee voted to enhance the usefulness of the ACS Directory of Graduate Research by including departmental telecopier, or fax, numbers and individual computer addresses in the 1989 edition. Plans were also approved to include departmental and biographical information from the directory in the ACS electronic communications network (ACS/ECOM). This service will be accessible through Telenet phone numbers and be available to ACS members and nonmembers.

The survey of construction projects at ACS-approved schools was continued in 1988. Schools indicated the phase of their construction (planning, in progress, completed in the last four years, or no construction) and the mode by which they would be willing to share information about their project (by phone, letter, or site visit). A complete listing of the results or a custom search by construction stage, communication medium, and geographic location can be obtained from the Office of Professional Training at ACS headquarters.

Other CPT activities in 1988 included preparation of an advisory statement to the National Science Foundation supporting the NSF initiative on the chemistry curriculum; endorsement of an Association of American Colleges project to produce a monograph on various undergraduate majors; participation in discussions of the ACS Agenda Relative to Long-Range Science Policy Issues; representation on the Committee on Professional Relations Task Force on Academic Guidelines; a presentation to the International Society for Optical Engineering; and interaction with the ACS Society Committee on Education Task Force on ACS Involvement in the Two-Year Colleges.

The committee would like to acknowledge and thank the following visiting associates of the committee who conducted on-site visits to schools on the approved list or applying for ACS approval during 1988: Martin N. Ackermann, Oberlin College; Ronald D. Archer, University of Massachusetts; Eugene C. Ashby, Georgia Institute of Technology; J. Nicholas Burnett, Davidson College; Roger L. DeKock, Calvin College; Robert W. Gleason, Middlebury College; Ronald C. Johnson, Emory University; William Jones, University of Florida; Royston M. Roberts, University of Texas; Robert I. Walter, University of Illinois, Chicago; Thomas Wartik, Pennsylvania State University; and Gene G. Wubbels, Grinnell College. □

Chemistry and chemical engineering degrees awarded by ACS-approved schools, 1987–88

	CHEMISTRY				CHEMICAL ENGINEERING		
	Bachelor's certified						
	Yes	No	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
Abilene Christian U	8	6	2	—			
Adelphi U	1	4	3	—			
Agnes Scott C	4	0	—	—			
Akron, U of	29	5	6	6	a		
Alabama, U of							
Birmingham	5	2	1	0			
Huntsville	1	6	2	—	a		
Tuscaloosa	3	11	2	2	30	4	1
Alaska, U of	5	1	2	—			
Albion C	1	8	—	—			
Albright C	2	12	—	—			
Alfred U	5	0	—	—			
Allegheny C	6	15	—	—			
Alma C	2	7	—	—			
American U	1	1	1	5			
Amherst C	1	11	—	—			
Andrews U	7	10	—	—			
Appalachian State U	5	4	0	—			
Arizona State U	14	14	1	11	21	7	2
Arizona, U of	10	49	6	19	21	4	0
Arkansas, U of							
Fayetteville	2	8	3	8	32	12	6
Little Rock	4	5	1	—			
Ashland C	0	4	—	—			
Auburn U	9	21	6	1	25	18	4
Augsburg C	2	8	—	—			
Augustana C							
Illinois	1	5	—	—			
South Dakota	0	9	—	—			
Austin C	2	7	—	—			
Baldwin-Wallace C	2	6	—	—			
Ball State U	8	5	9	—			
Barnard C	2	11	—	—			
Bates C	2	13	—	—			
Baylor U	5	15	1	1			
Beloit C	2	7	—	—			
Bemidji State U	7	6	—	—			
Birmingham Southern C	2	7	—	—			
Bloomsburg U	2	7	—	—			
Boston C	19	0	3	2			
Boston U	10	10	1	2			
Bowdoin C	1	32	—	—			
Bowling Green State U	5	10	13	0			
Bradley U	2	10	1	—			
Brandeis U	0	14	6	10			
Bridgeport, U of	1	0	2	—			
Bridgewater State C	3	6	0	—			
Brigham Young U	18	20	4	7	31	9	5
Brown U	0	12	4	16	2	0	1
Bryn Mawr C	21	0	0	3			
Bucknell U	6	16	3	—	17	4	—
Butler U	4	8	5	—			
California Institute of Tech	7	0	3	34	4	4	17
California Polytechnic State U	20	34	4	—			
California State Polytechnic U	2	7	4	—	a		
California State U							
Bakersfield	3	5	—	—			
Chico	0	20	—	—			
Dominguez Hill	2	2	—	—			
Fresno	7	7	4	—			
Fullerton	0	20	5	—			
Hayward	10	11	3	—			
Long Beach	23	22	14	—	a		
Los Angeles	9	3	4	—			
Northridge	4	20	3	—			
Sacramento	7	14	2	—			
San Bernardino	0	1	—	—			
Stanislaus	4	2	—	—			
California, U of							
Berkeley	67	1	6	75	72	15	32
Davis	23	8	5	11	30	8	3
Irvine	12	49	1	13			
Los Angeles	5	73	5	33	21	19	1
Riverside	8	0	8	13			
San Diego	29	0	32	27	a		
Santa Barbara	9	15	8	12	22	6	5
Santa Cruz	22	0	6	11			
Calvin C	4	14	—	—			
Canisius C	9	6	—	—			
Capital U	2	7	—	—			
Carleton C	1	24	—	—			
Carnegie Mellon U	20	1	1	10	37	7	11
Carroll C	0	3	—	—			
Carthage C	2	2	—	—			
Case Western Reserve U	7	42	10	9	24	11	1
Catholic U of America	0	4	3	1	a		
Centenary C of Louisiana	0	1	—	—			
Central C	0	9	—	—			
Central Connecticut State U	4	8	0	—			
Central Florida, U of	6	0	2	—			
Central Michigan U	1	10	3	—			
Central State U							
Ohio	0	0	—	—			
Oklahoma	0	4	—	—			
Centrel C	2	5	—	—			
Charleston, C of	5	4	—	—			
Chatham C	4	0	—	—			
Chestnut Hill C	4	3	—	—			
Chicago, U of	3	25	11	26			
Christian Brothers C[b]					a		
Cincinnati, U of	17	0	15	21	62	6	5
Citadel, The	2	2	—	—			
City U of New York							
Graduate Center	—	—	0	8			
Brooklyn C	1	28	5	—			
City C	3	5	7	—	a		
Herbert H. Lehman C	9	1	—	—			
Hunter C	1	9	0	0			
Queens C	1	17	10	3			
Clarion U	4	2	—	—			
Clark U	12	3	2	2			
Clarkson U	6	4	4	3	44	18	7
Clemson U	6	3	7	11	27	5	2
Cleveland State U	21	2	6	1	13	3	1
Coe C	1	4	—	—			
Colby C	3	5	—	—			
Colgate U	8	3	—	—			
Colorado C	8	1	—	—			
Colorado School of Mines	11	0	5	4	59	14	2
Colorado State U	9	13	3	14	14	13	1
Colorado, U of							
Boulder	7	37	10	24	45	10	7
Colorado Springs	4	1	—	—			
Denver	6	4	8	—			
Columbia U	4	11	17	10	20	17	7
Concordia C	5	7	—	—			
Connecticut, U of	12	12	17	5	25	7	5
Cooper Union[b]					a		
Cornell C	0	10	—	—			
Cornell U	27	27	28	20	33	5	8
Creighton U	3	14	—	—			
Dartmouth C	0	19	1	6			
David Lipscomb C	0	10	—	—			
Davidson C	3	6	—	—			
Dayton, U of	7	9	—	—	18	6	—
DePaul U	3	2	8	—			
DePauw U	2	9	—	—			
Delaware State C	9	0	5	—			
Delaware Valley C of Science & Agriculture	9	0	—	—			
Delaware, U of	22	12	9	12	35	1	13
Delta State U	1	12	—	—			
Denison U	2	9	—	—			
Denver, U of	1	8	6	2			
Detroit, U of	6	1	7	1	a		
Dickinson C	1	6	—	—			
Drake U	5	1	—	—			
Drew U	0	2	—	—			
Drexel U	6	0	9	4	59	9	3
Duke U	10	33	2	18			
Duquesne U	3	9	1	0			
Earlham C	0	5	—	—			
East Carolina U	3	4	2	—			

	CHEMISTRY				CHEMICAL ENGINEERING		
	Bachelor's certified						
	Yes	No	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
East Stroudsburg U	5	3	0	—			
East Tennessee State U	7	4	2	—			
East Texas State U	1	2	4	—			
Eastern Illinois U	13	2	5	—			
Eastern Kentucky U	6	21	1	—			
Eastern Michigan U	12	13	2	—			
Eastern New Mexico U	1	1	3	—			
Eckerd C	1	2	—	—			
Elizabethtown C	0	7	—	—			
Elmhurst C	1	14	—	—			
Emory U	4	39	9	8			
Emporia State U	5	5	2	—			
Evansville, U of	6	5	—	—			
Fairfield U	5	0	—	—			
Fairleigh Dickinson U							
Madison	6	0	2	—			
Teaneck	6	3	2	—			
Fisk U	5	1	2	—			
Florida Atlantic U	3	10	0	—			
Florida Institute of Tech	0	5	3	—	9	4	—
Florida International U	6	15	0	—			
Florida State U	1	22	5	5			
Florida, U of	4	34	9	28	27	4	12
Fordham U	0	15	2	—			
Fort Lewis C	4	6	—	—			
Franklin & Marshall C	7	2	—	—			
Furman U	10	9	1	—			
Geneva C	0	9	—	—			
George Mason U	6	3	—	—			
George Washington U	3	7	0	0			
Georgetown U	13	0	4	13			
Georgia Institute of Tech	14	0	6	16	72	9	14
Georgia State U	4	7	5	—			
Georgia, U of	4	11	2	7			
Gettysburg C	8	5	—	—			
Glassboro State C	3	2	—	—			
Gonzaga U	4	1	—	—			
Goucher C	1	1	—	—			
Grand Valley State C	0	8	—	—			
Grinnell C	3	15	—	—			
Gustavus Adolphus C	5	14	—	—			
Hamilton C	0	2	—	—			
Hamline U	5	5	—	—			
Hampden-Sydney C	4	3	—	—			
Hampton U	6	0	1	—			
Hartford, U of	1	5	0	—			
Hartwick C	0	2	—	—			
Harvard U	14	0	19	24			
Harvey Mudd C	15	0	—	—			
Haverford C	18	1	—	—			
Hawaii, U of, Manoa	10	3	2	1			
Hiram C	5	4	—	—			
Hobart & William Smith C	1	8	—	—			
Hofstra U	2	8	—	—			
Hollins C	0	1	—	—			
Holy Cross, C of the	10	16	—	—			
Hope C	10	13	—	—			
Houston, U of	12	0	9	8	25	36	6
Howard U	0	13	1	3	14	4	—
Humboldt State U	4	3	—	—			
Idaho State U	3	7	0	—			
Idaho, U of	3	8	5	6	17	8	3
Illinois Benedictine C	11	0	—	—			
Illinois Institute of Tech	8	0	7	0	a		
Illinois State U	30	6	9	—			
Illinois Wesleyan U	6	3	—	—			
Illinois, U of							
Chicago	15	7	17	11	24	6	5
Urbana-Champaign	59	71	22	43	69	18	17
Indiana State U	9	0	1	—			
Indiana U–Purdue U							
Fort Wayne	0	5	—	—			
Indianapolis	1	24	7	—			
Indiana U	24	124	10	27			
Indiana U Northwest	1	6	—	—			
Indiana U, South Bend	3	0	—	—			
Indiana U of Pennsylvania	8	8	1	—			
Interamerican U of Puerto Rico	2	5	—	—			
Iowa State U	12	7	10	36	57	8	9
Iowa, U of	20	4	8	8	19	7	4
Ithaca C	6	1	—	—			
Jackson State U	2	1	0	—			
James Madison U	4	11	—	—			
John Carroll C	2	5	1	—			
Johns Hopkins U	16	0	10	9	11	5	4
Juniata C	5	8	—	—			
Kalamazoo C	2	13	—	—			
Kansas State U	6	3	2	11	23	4	3
Kansas, U of	8	12	0	1	24	5	1
Kean C of New Jersey	4	8	—	—			
Kearney State C	0	7	—	—			
Kent State U	10	8	0	3			
Kentucky, U of	4	15	4	7	27	12	3
Kenyon C	3	9	—	—			
King's C	2	7	—	—			
Knox C	1	18	—	—			
La Salle U	3	1	—	—			
Lafayette C	6	7	—	—	11	—	—
Lake Forest C	1	5	—	—			
Lamar U	8	4	4	—	14	3	4
Lawrence Institute of Tech	8	0	—	—			
Lawrence U[c]	2	2	6	3			
LeMoyne C	6	2	—	—			
Lebanon Valley C	7	2	—	—			
Lehigh U	5	8	15	6	24	19	14
Lewis & Clark C	1	3	—	—			
Lincoln U	0	5	—	—			
Long Island U							
Brooklyn Campus	2	1	6	—			
C.W. Post Center	0	0	—	—			
Loras C	1	9	—	—			
Louisiana State U							
Baton Rouge	5	7	2	13	20	12	5
Shreveport	5	0	—	—			
Louisiana Technological U	2	3	3	—	16	4	2
Louisville, U of	12	11	1	4	10	4	1
Lowell, U of	4	4	9	8	19	5	—
Loyola C	0	3	—	—			
Loyola Marymount U	5	0	—	—			
Loyola U							
Chicago	9	16	5	2			
New Orleans	1	4	—	—			
Luther C	1	12	—	—			
Macalester C	2	3	—	—			
Maine, U of, Orono	1	2	1	1	26	3	0
Manhattan C[d]	5	9	—	—	12	10	—
Manhattanville C	2	0	—	—			
Mankato State U	2	9	0	—			
Marietta C	3	1	—	—			
Marist C	1	1	—	—			
Marquette U	17	0	4	4			
Marshall U	4	16	2	—			
Maryland, U of							
College Park	16	47	15	26	33	1	0
Baltimore County	10	32	0	0			
Massachusetts Institute of Tech	24	0	4	40	48	41	26
Massachusetts, U of	13	9	8	13	24	3	7
McNeese State U	2	1	2	—			
Memphis State U	2	6	1	1			
Mercer U	1	6	—	—			
Merrimack C	9	0	—	—			
Metropolitan State C	6	12	—	—			
Miami U	14	35	5	6			
Miami, U of	2	35	2	8			
Michigan State U	25	10	4	24	20	8	7
Michigan Technological U	8	0	5	0	40	5	0
Michigan, U of							
Ann Arbor	47	0	19	14	51	17	9
Dearborn	15	10	—	—			
Flint	4	2	—	—			
Middle Tennessee State U	0	16	6	—			
Middlebury C	0	4	0	—			
Midwestern State U	4	4	—	—			
Millersville U	1	9	—	—			
Millsaps C	1	14	—	—			
Minnesota, U of							
Duluth	14	9	5	—			
Minneapolis	43	0	7	30	91	12	20
Mississippi C	2	4	—	—			
Mississippi State U	1	12	1	3	30	0	—

	CHEMISTRY				CHEMICAL ENGINEERING		
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	Yes	No	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
Mississippi, U of	4	3	3	3	13	5	1
Missouri Western State C	2	0	—	—			
Missouri, U of							
Columbia	13	5	4	7	27	4	4
Kansas City	9	12	3	1			
Rolla	10	0	4	4	60	6	8
St. Louis	6	9	4	7			
Monmouth C	5	0	—	—			
Montana C of Mineral Science & Technology	2	1	0	—			
Montana State U	1	6	5	7	29	7	0
Montana, U of	7	4	5	3			
Montclair State C	7	12	4	—			
Moorhead State U	3	1	—	—			
Moravian C	0	3	—	—			
Morehouse C[c]	2	3	5	2			
Morgan State U	1	4	—	—			
Mount Holyoke C	0	7	0	0			
Mount Saint Vincent, C of[d]	0	1	—	—			
Muhlenberg C	0	9	—	—			
Murray State U	8	13	4	—			
Muskingum C	2	3	—	—			
Nebraska Wesleyan U	1	2	—	—			
Nebraska, U of							
Lincoln	0	8	4	15	36	6	1
Omaha	9	4	—	—			
Nevada, U of							
Las Vegas	1	5	0	—			
Reno	3	2	5	3			
New Hampshire, U of	6	4	2	6	19	6	1
New Jersey Institute of Tech[b]					43	13	2
New Mexico Highlands U	0	3	0	—			
New Mexico Institute of Mining & Tech	11	0	5	1			
New Mexico State U	0	19	4	7	23	3	0
New Mexico, U of	6	14	6	6	8	6	1
New Orleans, U of	6	7	0	4			
New York U	6	38	15	9			
Niagara U	0	5	—	—			
North Alabama, U of	7	11	—	—			
North Carolina A&T State U	2	0	1	—			
North Carolina Central U	1	6	2	—			
North Carolina State U	21	35	3	5	78	6	7
North Carolina, U of							
Asheville	2	1	—	—			
Chapel Hill	30	72	10	43			
Charlotte	2	5	1	—			
Greensboro	4	4	3	—			
Wilmington	5	13	—	—			
North Dakota State U	0	16	6	5			
North Dakota, U of	2	5	2	9	15	1	—
North Texas, U of	4	4	10	3			
Northeast Louisiana U	1	4	2	—			
Northeast Missouri State U	2	10	—	—			
Northeastern Illinois U	1	3	4	—			
Northeastern U	3	0	4	12	a		
Northern Arizona U	7	16	3	—			
Northern Colorado, U of	5	0	0	0			
Northern Illinois U	8	16	3	7			
Northern Iowa, U of	7	10	1	—			
Northern Kentucky U	2	8	—	—			
Northern Michigan U	0	3	0	—			
Northwest Missouri State U	3	1	—	—			
Northwestern State U of Louisiana	1	0	—	—			
Northwestern U	7	8	22	22	30	1	16
Notre Dame, U of	8	8	6	11	29	7	7
Oakland U	3	4	0	—			
Oberlin C	0	18	—	—			
Occidental C	1	14	—	—			
Ohio Northern U	4	4	—	—			
Ohio State U	33	0	0	38	40	15	6
Ohio U	5	6	2	7	15	5	1
Ohio Wesleyan U	1	4	—	—			
Oklahoma State U	0	2	2	7	22	14	7
Oklahoma, U of	11	19	12	4	21	23	6
Old Dominion U	5	1	7	—			
Oregon State U	13	0	4	14	24	11	3
Oregon, U of	5	25	5	11			
Pace U							
New York Campus	2	3	—	—			
Pleasantville Campus	3	4	—	—			
Pacific Lutheran U	3	8	—	—			
Pacific, U of the	4	3	0	0			
Pennsylvania State U	7	21	7	21	73	14	8
Pennsylvania, U of	4	16	5	19	25	5	15
Philadelphia C of Pharmacy & Science	1	0	1	1			
Philadelphia C of Textiles & Science	2	0	—	—			
Pittsburgh State U	4	1	2	—			
Pittsburgh, U of	14	38	14	15	41	17	6
Polytechnic U	3	0	14	7	11	15	6
Pomona C	6	7	—	—			
Portland State U	1	9	1	0			
Pratt Institute[b]					3	—	—
Princeton U	8	5	15	26	12	3	13
Providence C	2	9	0	0			
Puerto Rico, U of							
Mayaguez	9	2	4	—	55	2	—
Rio Piedras	6	23	8	4			
Puget Sound, U of	2	0	—	—			
Purdue U	21	18	13	35	73	14	12
Purdue U Calumet	7	3	—	—			
Ramapo C of New Jersey	1	3	—	—			
Randolph Macon C	0	3	—	—			
Randolph-Macon Woman's C	2	2	—	—			
Redlands, U of	1	3	—	—			
Reed C	7	1	—	—			
Rensselaer Polytechnic Institute	19	0	10	16	41	11	13
Rhode Island C	1	7	—	—			
Rhode Island, U of	7	3	2	6	16	6	1
Rhodes C	4	10	—	—			
Rice U	2	4	11	12	8	6	7
Richmond, U of	1	8	—	—			
Rider C	5	0	—	—			
Ripon C	1	3	—	—			
Roanoke C	2	1	—	—			
Rochester Institute of Tech	2	9	3	—			
Rochester, U of	9	3	32	16	22	13	4
Rollins C	2	0	—	—			
Roosevelt U	8	0	4	—			
Rose-Hulman Institute of Tech	4	0	—	—	31	3	—
Russell Sage C	2	1	—	—			
Rutgers U							
Camden C	0	12	—	—			
New Brunswick	20	33	13	14	27	29	8
Newark C of Arts & Sciences	9	4	9	2			
Saginaw Valley State C	2	9	—	—			
St. Anselm C	0	9	—	—			
St. Catherine, C of	3	5	—	—			
St. Cloud State U	4	9	—	—			
St. John Fisher C	2	5	—	—			
St. John's U/C of St. Benedict	4	6	—	—			
St. John's U	11	0	2	—			
St. Joseph C	4	2	4	—			
St. Joseph's U	5	13	6	—			
St. Lawrence U	3	8	—	—			
St. Louis U	2	32	5	—			
St. Mary's C	3	3	—	—			
St. Michael's C	2	0	—	—			
St. Olaf C	8	43	—	—			
St. Peter's C	2	2	—	—			
St. Thomas, C of	4	8	—	—			
Salem State C	2	0	—	—			
Sam Houston State U	5	1	3	—			
San Diego State U	14	0	9	0			
San Francisco State U	6	24	9	—			
San Francisco, U of	1	6	4	—			
San Jose State U	21	6	9	—	a		
Sangamon State U	1	0	—	—			
Santa Clara U	4	5	—	—			
Scranton, U of	2	11	12	—			
Seattle U	0	4	—	—			
Seton Hall U	3	9	9	4			
Shippensburg U	6	6	2	—			
Siena C	9	0	—	—			
Simmons C	0	0	—	—			
Skidmore C	1	16	—	—			
Smith C	2	3	0	0			
Sonoma State U	4	9	—	—			
South Alabama, U of[b]					20	1	—

	CHEMISTRY				CHEMICAL ENGINEERING		
	Bachelor's certified						
	Yes	No	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
South Carolina, U of	2	20	5	29	28	7	1
South Dakota School of Mines & Tech	5	0	1	—	25	2	—
South Dakota State U	1	29	6	—			
South Dakota, U of	8	13	2	—			
South Florida, U of	22	27	3	2	22	6	1
Southeast Missouri State U	0	8	—	—			
Southeastern Louisiana U	4	0	—	—			
Southeastern Massachusetts U	6	5	3	—			
Southern California, U of	16	2	1	11	16	6	3
Southern Colorado, U of	0	5	0	—			
Southern Illinois U							
Carbondale	12	1	5	8			
Edwardsville	19	5	6	—			
Southern Methodist U	6	7	1	—			
Southern Mississippi, U of	1	14	4	1			
Southern Oregon State C	2	2	—	—			
Southern U and A&M C	3	2	5	—			
Southwest Missouri State U	8	14	—	—			
Southwest State U	1	1	—	—			
Southwest Texas State U	10	3	3	—			
Southwestern Louisiana, U of	0	17	1	—	13	6	—
Southwestern Oklahoma State U	6	5	—	—			
Stanford U	6	6	4	31	12	17	12
State U of New York							
Albany	10	11	8	7			
Binghamton	5	14	6	5			
Buffalo	19	9	4	15	31	15	11
Stony Brook	10	29	5	14			
C of Brockport	3	6	—	—			
C at Buffalo	9	11	3	—			
C at Cortland	7	4	—	—			
C at Fredonia	6	4	1	—			
C at Geneseo	9	4	—	—			
C at New Paltz	8	1	4	—			
C at Oneonta	1	10	0	—			
C at Oswego	9	2	2	—			
C at Plattsburgh	5	14	3	—			
C at Potsdam	0	8	—	—			
Stephen F. Austin State U	6	0	0	—			
Stetson U	3	2	—	—			
Stevens Institute of Tech	3	2	4	3	8	8	2
Stockton State C	2	15	—	—			
Suffolk U	1	1	—	—			
Susquehanna U	1	3	—	—			
Swarthmore C	6	5	—	—			
Syracuse U	8	5	0	11	9	5	3
Temple U	19	0	3	4			
Tennessee Technological U	2	5	3	—	18	4	0
Tennessee, U of							
Chattanooga	9	14	—	—			
Knoxville	2	8	6	18	36	13	3
Martin	3	6	—	—			
Texas A&I U	2	0	3	—	18	7	0
Texas A&M U	8	14	16	29	69	10	7
Texas Christian U	3	10	1	7			
Texas Southern U	9	0	4	—			
Texas Tech U	2	5	3	8	5	10	1
Texas Woman's U	0	4	4	0			
Texas, U							
Arlington	9	13	2	4			
Austin	49	0	11	17	41	15	18
Dallas	7	1	5	1			
El Paso	10	1	12	—			
Thiel C	0	5	—	—			
Thomas More C	3	0	—	—			
Toledo, U of	3	9	2	2	20	4	0
Towson State U	2	12	—	—			
Trenton State C	14	0	—	—			
Trinity C	11	6	1	—			
Trinity U	5	6	—	—			
Tri-State U[b]					15	—	—
Tufts U	1	10	1	6	14	11	1
Tulane U of Louisiana	2	7	0	1	8	3	1
Tulsa, U of	5	0	—	—	a		
Tuskegee U	0	3	3	—	5	—	—
Union C	4	10	—	—			
U.S. Air Force Academy	12	2	—	—			
U.S. Naval Academy	14	6	—	—			
Ursinus C	4	10	—	—			
Utah State U	8	0	1	4			
Utah, U of	3	16	9	25	29	2	5
Valparaiso U	3	32	—	—			
Vanderbilt U	0	10	4	4	20	3	1
Vassar C	0	5	0	—			
Vermont, U of	16	0	1	10			
Villanova U	10	0	8	1	12	4	—
Virginia Commonwealth U	4	15	3	6			
Virginia Military Institute	4	0	—	—			
Virginia Polytechnic Institute & State U	15	19	8	13	44	9	5
Virginia, U of	11	52	15	14	25	18	7
Wabash C	7	11	—	—			
Wagner C	1	2	—	—			
Wake Forest U	0	32	3	1			
Washburn U of Topeka	4	2	—	—			
Washington C	1	0	—	—			
Washington State U	4	6	7	4	23	7	3
Washington U	2	6	12	9	26	15	4
Washington & Jefferson C	1	23	—	—			
Washington & Lee U	1	12	—	—			
Washington, U of	16	29	14	21	67	6	4
Wayne State U	37	13	17	22	28	13	2
Waynesburg C	0	0	—	—			
Weber State C	4	2	—	—			
Wellesley C	13	24	—	—			
Wesleyan U	0	7	0	2			
West Chester U	3	13	5	—			
West Florida, U of	4	5	—	—			
West Texas State U	0	9	1	—			
West Virginia Institute of Tech[b]					11	0	—
West Virginia State C	3	6	—	—			
West Virginia U	14	28	4	4	21	6	2
Western Illinois U	1	8	2	—			
Western Kentucky U	0	10	2	—			
Western Maryland C	2	3	—	—			
Western Michigan U	1	14	4	2			
Western New England C	0	0	—	—			
Western Washington U	11	11	2	—			
Westminster C	1	2	—	—			
Wheaton C							
Illinois	3	10	—	—			
Massachusetts	2	2	—	—			
Wheeling Jesuit C	1	8	—	—			
Whitman C	3	2	—	—			
Whittier C	2	7	—	—			
Wichita State U	6	8	3	0			
Widener U	3	2	—	—	7	2	—
Wilkes C	2	1	—	—			
Willamette U	1	11	—	—			
William Paterson C of N.J.	0	3	—	—			
William & Mary, C of	24	8	4	—			
Williams C	5	31	—	—			
Winona State U	2	2	—	—			
Wisconsin, U of							
Eau Claire	10	11	—	—			
Green Bay	0	6	—	—			
La Crosse	0	13	—	—			
Madison	38	0	13	41	68	10	18
Milwaukee	0	13	6	8			
Oshkosh	8	0	—	—			
Parkside	6	2	—	—			
Platteville	0	3	—	—			
River Falls	11	7	—	—			
Stevens Point	7	15	—	—			
Superior	2	2	—	—			
Wittenberg U	4	8	—	—			
Wooster, C of	3	29	—	—			
Worcester Polytechnic Institute	42	5	1	0	34	2	5
Wright State U	20	9	13	—			
Wyoming, U of	8	0	4	5	7	3	4
Xavier U	5	6	—	—			
Xavier U of Louisiana	2	39	—	—			
Yale U	0	15	15	22	2	3	3
Youngstown State U	8	44	5	—	a		
TOTALS	3428	4843	1584	1955	3577	1049	617

NOTE: For brevity, B.S. and M.S. are used to denote all bachelor's and master's degrees, respectively, in each column. a Data not submitted. b Listed on basis of accreditation by AIChE-ABET. c Master's and Ph.D. degrees given by the Institute of Paper Chemistry. d The chemistry programs at Mount Saint Vincent and Manhattan College are integrated into a combined department with all instruction in chemistry located at Manhattan College. • Master's and Ph.D. degrees given by Atlanta University.

Berkeley, Illinois top producers of chemists

The University of California, Berkeley, was the dominant producer of new Ph.D. chemists in the 1987–88 academic year, with 75. The University of Illinois, Urbana-Champaign, and University of North Carolina, Chapel Hill, shared the second spot with 43 each.

This was the fourth year in a row and the seventh time in the past 15 years that Berkeley has topped the Ph.D. list. In the other years the honor went to Urbana-Champaign.

These are but some of the facts that can be extracted from the statistical data contained in the latest annual report of ACS's Committee on Professional Training (CPT) (see page 93). The report includes the number of new doctoral, master's, and bachelor's degree graduates from all chemistry departments with CPT-approved bachelor programs.

Indiana University was the largest producer of bachelor's degree chemists, with 148, in 1987–88, as it had been for the previous three years. Urbana-Champaign hung on to the second position with 130. And Chapel Hill, with 102, moved up from the fifth spot to take the third.

Berkeley produced the most chemists, 67, with bachelor's degrees certified by ACS. The University of Texas, Austin, with 49, slipped from the top spot in 1986–87 to third; Urbana-Champaign was second with 59. Certified graduates are immediately eligible for membership in ACS.

The University of California, San Diego, and the University of Rochester produced the most new master's chemists in 1987–88 with 32 each. Cornell University, the biggest producer the previous year, slipped to third with 28.

The chemistry departments at Urbana-Champaign and Wayne State University were the only two to rank in the first 25 for all categories—total bachelor's graduates, ACS-certified bachelor's graduates, masters, and Ph.D.s.

The University of Minneapolis, Minnesota, produced the most bachelor's degree chemical engineers in 1987–88, with 91.

Michael Heylin

These schools had the most chemistry graduates, 1987–88

Total bachelor graduates

1.	Indiana U	148
2.	U of Illinois, Urbana-Champaign	130
3.	U of North Carolina, Chapel Hill	102
4.	U of California, Los Angeles	78
5.	U of California, Berkeley	68
6.	U of Maryland, College Park	63
6.	U of Virginia	63
8.	U of California, Irvine	61
9.	U of Arizona	59
10.	North Carolina State U	56
11.	California Poly Tech State U	54
11.	Cornell U	54
13.	Rutgers U, New Brunswick	53
14.	U of Pittsburgh	52
14.	Youngstown State U	52
16.	St. Olaf C	51
17.	Wayne State U	50
18.	Case Western Reserve U	49
18.	Miami U	49
18.	U of South Florida	49
18.	U of Texas, Austin	49
22.	U of Michigan, Ann Arbor	47
23.	California State U, Long Beach	45
23.	U of Washington	45
25.	U of Colorado, Boulder	44
25.	New York U	44

Certified bachelor graduates

1.	U of California, Berkeley	67
2.	U of Illinois, Urbana-Champaign	59
3.	U of Texas, Austin	49
4.	U of Michigan, Ann Arbor	47
5.	U of Minnesota, Minneapolis	43
6.	U of Wisconsin, Madison	38
7.	Wayne State U	37
8.	Ohio State U	33
9.	Illinois State U	30
9.	U of North Carolina, Chapel Hill	30
11.	U of Akron	29
11.	U of California, San Diego	29
13.	Cornell U	27
14.	Michigan State U	25
15.	Indiana U	24
15.	Massachusetts Inst of Tech	24
15.	College of William & Mary	24
18.	California State U, Long Beach	23
18.	U of California, Davis	23
20.	U of California, Santa Cruz	22
20.	U of Delaware	22
20.	U of South Florida	22
23.	Bryn Mawr C	21
23.	Cleveland State U	21
23.	North Carolina State U	21
23.	Purdue U	21
23.	San Jose State U	21

Masters graduates

1.	U of California, San Diego	32
1.	U of Rochester	32
3.	Cornell U	28
4.	U of Illinois, Urbana-Champaign	22
4.	Northwestern U	22
6.	Harvard U	19
6.	U of Michigan, Ann Arbor	19
8.	Columbia U	17
8.	U of Connecticut	17
8.	U of Illinois, Chicago	17
8.	Wayne State U	17
12.	Texas A&M U	16
13.	U of Cincinnati	15
13.	Lehigh U	15
13.	U of Maryland, College Park	15
13.	New York U	15
13.	Princeton U	15
13.	U of Virginia	15
13.	Yale U	15
20.	California State U, Long Beach	14
20.	U of Pittsburgh	14
20.	Polytechnic U	14
20.	U of Washington	14
24.	Bowling Green State U	13
24.	Purdue U	13
24.	Rutgers U, New Brunswick	13
24.	U of Wisconsin, Madison	13
24.	Wright State U	13

Doctoral graduates

1.	U of California, Berkeley	75
2.	U of Illinois, Urbana-Champaign	43
2.	U of North Carolina, Chapel Hill	43
4.	U of Wisconsin, Madison	41
5.	Massachusetts Inst of Tech	40
6.	Ohio State U	38
7.	Iowa State U	36
8.	Purdue U	35
9.	California Inst of Tech	34
10.	U of California, Los Angeles	33
11.	Stanford U	31
12.	U of Minnesota, Minneapolis	30
13.	U of South Carolina	29
13.	Texas A&M U	29
15.	U of Florida	28
16.	U of California, San Diego	27
16.	Indiana U	27
18.	U of Chicago	26
18.	U of Maryland, College Park	26
18.	Princeton U	26
21.	U of Utah	25
22.	U of Colorado, Boulder	24
22.	Harvard U	24
22.	Michigan State U	24
25.	Northwestern U	22
25.	Wayne State U	22
25.	Yale U	22